Near Future trends in Interactive Media Convergence Using Quantitative and Qualitative Approaches

Fleury, Alexandre

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Near-future trends in interactive media convergence using quantitative and qualitative approaches

PhD Thesis

Alexandre Fleury

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Supervisor
Associate Professor Lars Bo Larsen

Aalborg University
Department of Electronic Systems
Section for Multimedia Information and Signal Processing

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Abstract

With the democratization of ubiquitous media consumption, it is no longer a requirement to possess dedicated fixed media receivers in order to enjoy TV-, radio- or Internet based information and to share experiences of it with peers. New generation mobile technologies transformed what used to be a one to one communication device (the mobile phone) into a many to many communication platform, fully integrated in our personal media environment.

This thesis explores the convergence of television and mobile technologies and its impact on the user experience with ubiquitous media consumption. Rooted in convergence, mobility and user experience theories, empirical studies of mobile / TV convergence are presented in order to inform future developments of converged media services. The following four aspects of such convergence were investigated through various trials: personal relationships with mobile and TV, potential contexts for mobile TV consumption, acceptability and feasibility of second screen, and transfer of content across media devices. These experiments were conducted in the context of a four year Danish iterative platform project and a six month research trip to Japan, which allows brief cultural comparison and discussion.

Studying these general and particular issues was done by revisiting the user experience research toolbox, both for exploring concepts and for evaluating prototypes with potential end-users of converged media services. Concerning the former, semi-structured and expert interviews, surveys, scenario- and acting-based workshops as well as drawings were used to document current behaviour and identify potential future ones. In parallel, functional prototypes were developed and evaluated through situated task-based interviews, remote SMS prompting, as well as various lab-based usability experiments (in a simulated environment or as a Wizard-of-Oz) during which participant behaviour was recorded to further appreciate their input.

Overall the general concept of ubiquitous media and in particular the closer integration of mobile and television experiences are anticipated and positively welcomed by early technology adopters, and supported by broadcasters. As seen from a user perspective, technological, social and cultural issues however still need to be tackled in order to ensure the successful adoption of future converged media products and services. As discussed throughout the work documented in this thesis, such pending issues include platform capability, content and service relevance, and price adequacy.

Based on a cost analysis of the user research methods discussed throughout this dissertation, some inquiry methods appear more cost efficient at producing valuable data. Nevertheless, the application of the different techniques is found suitable and fits well the cyclic, iterative process of the research project they have been applied to. In particular among the less common methods, participant-generated drawings proved to generate useful insight on users' personal relationship with media technology, and at a limited cost.

Resumé

Med udbredelsen af det moderne medieforbrug er det ikke længere et krav at eje en stationær medieplatform for at kunne se TV, høre radio eller søge informationer på nettet, samt dele disse oplevelser med venner. Den nye generation af mobilteknologier har omdannet hvad der førhen var et en-til-en kommunikationsapparat (mobiltelefonen) til en mange-til-mange kommunikationsplatform, som er fuldt integreret i vores personlige mediemiljø.

Denne afhandling undersøger konvergensen af TV og mobilteknologier og indflydelsen på brugeren. Med basis i konvergens, mobilitet og user experience teorier præsenteres empiriske studier af mobil- og TV-konvergens for at få et billede af fremtidige konvergerede medieservices. De følgende fire aspekter af denne konvergens er blevet undersøgt i diverse tests: personlige forhold til mobiltelefoni og TV, mulige situationer med mobilt TV forbrug, acceptabilitet, og muligheder med sekundær skærm og flytning af indhold mellem enheder. Disse eksperimenter er blevet udført over en periode af fire år i et dansk platformsprojekt og et seksmåneders udvekslingsforløb i Japan, som gjorde det muligt sammenligne og diskutere eventuelle kulturforskelle.

Studier af disse generelle og specifikke emner blev gennemført ved brug af user experience research metoder, både til at undersøge koncepter samt evaluere prototyper med slutbrugere af konvergerede medieservices. Sammen med de tidligere nævnte semi-strukturede og ekspert interviews er der også anvendt spørgeskemaundersøgelser, situations- og handlingsbaserede workshops, samt tegninger til at dokumentere den nuværende og potentielt fremtidige adfærd. Der er i denne forbindelse udviklet fungevende prototyper, som er blevet evalueret gennem opgavebaserede interviews, SMS undersøgelser, samt forskellige usability tests gennemført i simuleret miljø eller som Wizard-of-Oz. Under disse forsøg er testpersonernes adfærd blevet optaget til senere analyse.

Overordnet er den generelle accept af medieforbruget og særligt den tætte integration af mobiltelefon og TV forventet og meget vel modtages af specielt meget unge brugere, og understøttes af udbydere. Set fra brugerens perspektiv er der dog stadig teknologiske, sociale og kulturelle aspekter, som kræver en del overvejelse inden fremtidens konvergerede medieprodukter og services kan blive en succes. Som det også fremgår af denne afhandling inkluderer disse uafklarede aspekter også platformenes kapacitet, indhold og relevante services, samt pris.

Baseret på en analyse af omkostningerne ved forskningsmetoderne, er det klart at nogle metoder er mindre omkostningskrævende til at frembringe brugbare data end andre. Applikationen af de forskellige teknikker passer dog godt til forskningsprojektes, iterative proces hvori de har været anvendt. Specielt den mindre udbredte metode, hvor brugeren laver illustrationer har vist sig at give en god indsigt i brugerens personlige forholdt til medieteknologi - og dette for meget få midler.

" If you want to run, run a mile. If you want to experience a different life, run a marathon."

Emil Zatopek

Final draft

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PREFACE

Acknowledgements

First of all I would like to acknowledge the institutions that hosted me throughout my PhD studies: the section for Multimedia Information and Signal Processing at Aalborg University and the Interfaculty Initiative in Information Studies at The University of Tokyo. In addition, thank you to The Obel Family Foundation for partially bearing the cost of my stay in Japan.

Most importantly, I am grateful to a number of people who supported my work throughout the process of writing this dissertation. In particular I deeply thank my supervisor Lars Bo Larsen, whose inspiring guidance helped me keep focus on my objectives, and whose careful counselling has been consistently enlightening and encouraging since I first set foot in Denmark in 2006. Thank you also to all members of the CAMMP project, for the fruitful collaboration and meetings always worth looking forward to.

I am also very much indebted to the three members of my Assessment Committee: Doctor David Geerts, Research Manager at the Centre for User Experience Research at KU Leuven, Professor Markku Turunen from the School of Information Sciences at the University of Tempere, and Professor Søren Bech, from the department of Electronic Systems at Aalborg University. THank you for taking the time to review my dissertation and providing invaluable insights to improve its quality.

From MISP I am thankful to Søren, extremely supportive section head, to Charlotte, unbelievably helpful and efficient secretary, and to all the members of the section who make working in the A6-3xx corridor a joyful and constructive experience. Special thanks to the Misky club fellows for the rich, smooth, and single malt moments.

My stay in Japan has been a priceless addition to an already rich journey. For this I am grateful to Aske Dam who introduced me to a fantastic team of researchers at TODAI. In particular I deeply thank Mizukoshi-sensei, who welcomed me in his lab, took me under his wing during six (way too short) months, and placed me in the hands of incredible scholars and professionals. A thank you to all members of the MELL project, and fellow graduate students from *Mizukoshi no yukari*.

This thesis contains insights gathered from interviews conducted both in Japan and Denmark. In addition to Mizukoshi-sensei, and following the chronological order of those interviews, thank you Yonnie, Gift, Niida-san, Furukawa-san, Jacob, and Johan for taking the time to answer my questions and for sharing your expertise and wisdom.

By definition user experience studies rely on input from test participants. I address my gratitude to all of you whose input is reported in this thesis. Thanks for taking the time to discuss intricate concepts, to evaluate our (sometimes shaky) prototypes, and to report on your experience. Your involvement will help shape the future of converging media technologies.

On a personal note, I am much indebted to Jakob not only for being a remarkable and dedicated colleague, but also for being such a great friend. Sharing an office with you all these years made work look like so much fun! As we used to say, this is one of the good ones!

All my sympathy goes to my local and remote friends, who inspire me, make me laugh, and push me forward. You are like familiar faces sheering along a marathon, your presence is precious and makes me go further on.

Finally, I could not be better inspired than by looking at my own family, whose unconditional support is the best source of motivation. Un grand merci à vous.

Alexandre

Notes about language and disclaimer

In general the text of this thesis is written in British English, unless quoting English speakers from other regions. Statements in other languages are reproduced in their translated form. Japanese professors and individuals are referred to following the Japanese custom of appending the suffixes -sensei or -san to their name. In the sections discussing mobile phones in Japan, mobile phones are also referred to as *keitai*, a definition of which is provided the first time it is encountered in the text. Some sections of the thesis are based on interviews of academic and industrial professionals. Their opinions expressed in the text are their own and are not necessarily representative of the institution they work for.

Bibliographical references are cited in the text by their first author name and year of publication, such as Abowd et al. (1999). In addition to these academic references, links to online articles and websites are available in footnotes throughout the text. Footnotes are also used to translate foreign terms and to provide concise definitions.

Scope and context of the Study

The present thesis has been conducted in the context of the CAMMP project, in which the department of Electronic Systems at Aalborg University has been a leading partner. In addition, part of the research accounted for in this thesis took place during a six month visit at the Interfaculty Initiative in Information Studies at the University of Tokyo. This section introduces these main sources of influence for the study.

As a result, the study is primarily focused on Europe and East Asia. While we reckon that other markets such as the USA or emerging ICT markets would be highly interesting to study as well, the purpose of this dissertation is less to strictly compare Europe and East Asia (let alone other regions) than to use those two regions as representative of highly developed ICT markets to which cultural specificities apply. Such differences will be considered when analysing data collected in both regions, but these are not the main focus of the study.

Converged Advanced Mobile Media Platforms

The Converged Advanced Mobile Media Platforms project, or CAMMP[1], explores the convergence of 3G+ mobile technologies with today's main media (Internet, digital TV and radio). The four-year project is funded by the Danish Advanced Technology Foundation, or HTF[2]. It gathers industrial and academic partners involved in the following areas, or work packages (WPx).

WP1 User requirements and validation

WP2 Design, integration and implementation of physical infrastructure

[1] CAMMP homepage: http://www.cammp.aau.dk/ (March 6th, 2012).

[2] Højteknologifonden homepage: http://hoejteknologifonden.dk/ (March 6th, 2012).

WP3 Design and implementation of service and content architecture and the mobile media service platform

WP4 Market and regulation

WP5 Dissemination and training

The research reported in this thesis has been an active contribution to the outcome of WP1, and includes elements of collaboration with WP3. Contribution to Work Package 1 consisted in identifying key research areas relevant to CAMMP and including them into the project plan, conducting user studies in accordance to the proposed project plan, and disseminating the results of these studies by means of scientific publications and presentations at academic conferences. These user studies are presented in detail in the following chapters of this thesis to illustrate corresponding theoretical discussions. Active collaboration with Work Package 3 has occurred throughout the project via joint formulation of plans for CAMMP, recurrent discussions on common research topics, as well as concrete design and implementation of user studies.

Academic Institutions

Section for Multimedia Information and Signal Processing (MISP), Aalborg University, Denmark

The section for Multimedia Information and Signal Processing belongs to the Electronic Systems department of Aalborg University. The section focuses its activities on developing improved multimedia systems and on evaluating the interaction with such systems from a usability and user experience perspective. Mobile platforms are of special interest regarding the study of multimodal user interfaces with end users. MISP staff is involved in teaching topics ranging from signal processing to optimization and usability engineering. This multifaceted perspective on multimedia systems set the ground for the multidisciplinary approach taken in this thesis. Lars Bo Larsen, Professor at MISP, has been the principal supervisor for my PhD thesis. He is actively involved in the section's research and teaching activities, where he is lecturing about multimodal systems, human-computer interaction and usability evaluation.

Interfaculty Initiative in Information Studies (III), The University of Tokyo, Japan

The purpose of my stay abroad was to support and enrich this PhD study in various ways. During my six month stay in Japan (between October 2010 and April 2011) I experienced one of the most advanced (yet relatively unknown from a European point of view) societies regarding mobile technologies; I interviewed key actors in the field of new mobile media (academics, engineers from phone manufacturers, executives from national broadcasters); and I actively took part in the various local and national projects conducted in which my host professor, Shin Mizukoshi, is engaged. Mizukoshi-sensei teaches media literacy and advocates socio-media studies from a socio-historical perspective rather than technological. Under his guidance, I set up and conducted two

concrete user studies from which I collected valuable data. These user experiments are described in details in the following chapters.

User studies and paper contributions

Although this dissertation can be read as a self contained piece of academic work, it relies on a number of scientific publications produced during the project. Some sections are therefore directly inspired by such publications, in which case the section's preamble indicates the related publication(s) it refers to. In particular, most of the studies considered for this thesis and reported in the practical sections of the thesis have been published or are under consideration for publication. The list of such studies are briefly introduced here, although they will be thoroughly examined throughout the thesis. A chronological representation of the studies as they were conducted throughout the course of writing this thesis is provided in Figure 1. It should be noted however that the discussion of these user studies in the following chapters do not reflect the order with in they were conducted.

Study #1: Mobile TV consumption in a social context
Situated task based interviews

Study #2: Competition / collaboration with mobile media
Semi-structured group interviews

Study #3: Acceptability of video content switching delay
Usability evaluation of a low-fidelity prototype under various conditions simulated in a lab

Study #4: Usability of video handover across multiple devices
Usability evaluation of various prototypes in a lab-based Wizard-of-Oz approach

Study #5: Quick ethnography of TV and mobile phone personal use
Collection of user-made drawings exploring personal experiences

Study #6: Creative exploration of TV/mobile convergence
Drama-based workshop exploring personal experiences

Study #7: MiniTV survey
Longitudinal SMS-based remote prompting of end users of a commercial mobile TV service

Study #8: Second screen workshops
Task-based semi-structures group evaluation of high-fidelity prototypes

Study #9: Expert interviews
Semi-structured interviews with scholars and professionals in the field of cross-media

Study #10: Survey on everyday media use in Japan and Denmark
Online questionnaire on current media usage in two countries with high media penetration

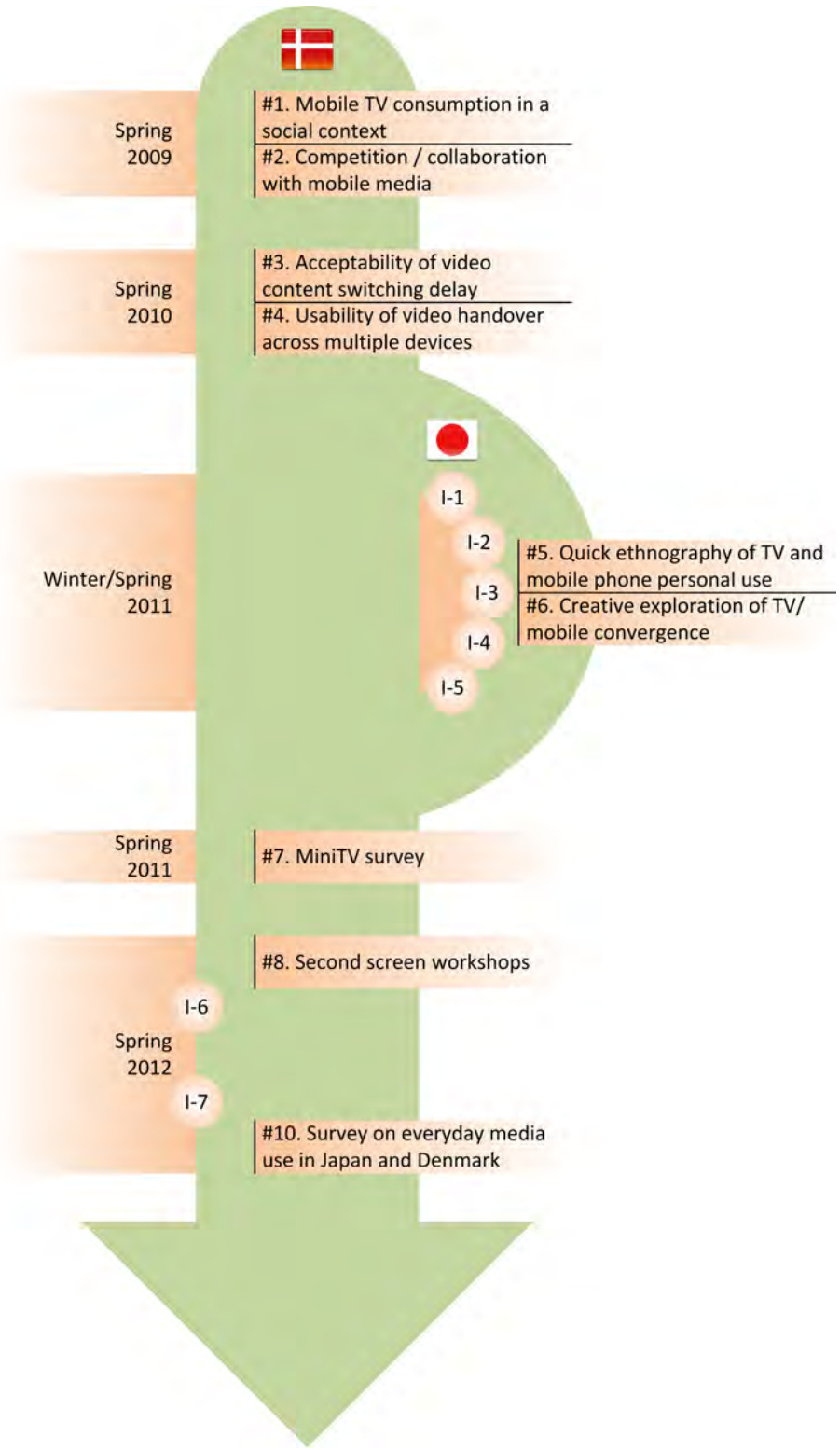


Figure 1: Chronological representation of the user studies reported in this thesis. I-*x*: Expert Interviews (study #9).

The following scientific publications are directly related to the above-mentioned user studies and are referred to throughout this dissertation. Most chapters are revisions of these articles, the content of which is disseminated in the text of this thesis according to Table 1. These eight articles are reproduced in appendices for reference.

- *Appendix A p. 295*
  Fleury, A., Pedersen, J. S., & Larsen, L. B. (2009). Two perspectives on mobile television: Consumption in a social context and collaborative/-competitive behaviors. In O. W. Bertelsen & A. M. Kanstrup (Eds.), *Proceedings of the Ninth Danish Human-Computer Interaction Research Symposium* (pp. 18–21)
- *Appendix B p. 301*
  Fleury, A., Pedersen, J. S., & Larsen, L. B. (2011b). Acceptable channel switching delays for mobile tv. In *Proceedings of the International Interactive Conference on Interactive Television (EuroITV)*, EuroITV '11 (pp. 195–198). New York, NY, USA: ACM
- *Appendix C p. 307*
  Fleury, A., Pedersen, J., & Larsen, L. (2011a). Evaluating ubiquitous media usability challenges: Content transfer and channel switching delays. In A. Marcus (Ed.), *Design, User Experience, and Usability. Theory, Methods, Tools and Practice*, volume 6770 of *Lecture Notes in Computer Science* (pp. 404–413). Springer Berlin / Heidelberg
- *Appendix D p. 319*
  Fleury, A. (2011). Drawing as a user experience research tool. In M. Bødker, A. Nawaz, & G. S. Petersen (Eds.), *Proceedings of the 11th Danish HCI Research Symposium* (pp. 14–17)
- *Appendix E p. 325*
  Pedersen, J. S., Larsen, L. B., & Fleury, A. (2011). Experience sampling as a study method of mobile media consumption. In M. Bødker, A. Nawaz, & G. S. Petersen (Eds.), *Proceedings of the 11th Danish HCI Research Symposium DHRS2011* (pp. 26–29)
- *Appendix F p. 331*
  Fleury, A. (2012). Drawing and acting as user experience research tools. In *Proceedings of the 10th asia pacific conference on Computer human interaction*, APCHI '12 (pp. 269–278). New York, NY, USA: ACM
- *Appendix G p. 343*
  Fleury, A., Pedersen, J. S., Baunstrup, M., & Larsen, L. B. (2012a). Interactive tv: Interaction and control in second-screen tv consumption. In *Adjunct proceedings of the 10th European interactive TV conference (EuroITV)*
- *Appendix H p. 349*
  Fleury, A., Pedersen, J. S., & Larsen, L. B. (2012b). Evaluating user preferences for video transfer methods from a mobile device to a tv screen. In *To appear Pervasive and Mobile Computing*. Elsevier

Finally, additional relevant material written throughout the course of the thesis project consists of the following articles and deliverables related to

Table 1: Contribution of scientific publications to the thesis sections.

User studies	Publications	Thesis sections
#1	Fleury et al. (2009)	3.2, 5.2, 6.2
#2	Fleury et al. (2009)	3.2, 5.2
#3	Fleury et al. (2011b,a)	3.2, 5.2, 6.3
#4	Fleury et al. (2011a, 2012b)	3.4, 5.2, 6.4
#5	Fleury (2011, 2012)	3.1, 5.2, 5.4
#6	Fleury (2012)	3.1, 5.2, 5.3
#7	Pedersen et al. (2011)	3.2, 5.2, 6.1
#8	Fleury et al. (2012a)	3.3, 5.2
#9	Unpublished	1.1, 1.2, 2.1 and 2.3
#10	Unpublished	2.4, 5.1

CAMMP. These publications are however not directly referred to in the body of the dissertations, but instead could provide the interested reader with additional material to understand the foundation of the work presented.

- Pedersen, J. S., Fleury, A., Sørensen, L., Heinze, E., Nicolajsen, H. W., Winbladh, J., & Wieland, J. L. (2009). *State of The Art Literature Study of Methods for Evaluation Framework*. Technical report, Aalborg University. CAMMP deliverable D1.2
- Fleury, A., Pedersen, J. S., & Larsen, L. B. (2010). A pragmatic approach to testing issues in a mobile platform that does not yet exist. In C. Peng, P. V. abd Pertti Näränen, & C. Quico (Eds.), *Adjunct proceedings of the 8th European Conference on Interactive TV and Video (EuroITV2010)* (pp. 262–263)
- Fleury, A. (2010). Converged mobile media: Evaluation of an interactive user experience. In *Adjunct proceedings of the 8th European Conference on Interactive TV and Video (EuroITV2010)* (pp. 18–21). Awarded best PhD paper
- A number of chapters and sections of Internal Reports for the CAMMP projects concerned with state-of-the art research methods, as well as with the planning, design, and results of user studies

CHAPTER 1

INTRODUCTION

1.1 New media: interactive and mobile

This section frames the thesis by defining its scope and the key concepts it investigates. It also offers a short review of some of the recent developments in converging media in Europe, focusing primarily on the new possibilities offered by the combination of television and mobile technologies. The enthusiastic days of mobile TV in Europe circa 2003 and the high expectations toward mobile broadcast TV in the following years (roughly until 2006) is used as a starting point[1]. The technological, economical and regulatory reasons behind the slow European uptake are briefly explained and put in light of the successes of various mobile media in East Asia. The recent academic and industrial (re)focus on interactive TV (iTV) is then examined to introduce the reader to other scenarios involving televisions and mobile phones. Finally, contexts relevant to mobile media consumption are introduced to scope the user studies reported in the following chapters.

What's so new about New Media?

The 2003 special issue of Sage's *new media & society* reflected on the progress that had occurred in the past five years in new media research. Lievrouw noticed that new media became "mainstream" and as a result taken for granted, and that new media use became "interior", that is qualitative, focusing on "micro-scale meaning and experiences" (Lievrouw, 2004). A few years later in a 2006 special report about new media, *The Economist* asked two 'gazillion-dollar questions': *What is a new media company?*[2]; and *What sort of revolution is*

[1] The reader interested in earlier mobile TV systems could refer to Frank Güntör's *Short history of pocket-TV*: http://www.guenthoer.de/e-history.htm (March 12th, 2012).

[2] *The gazillion-dollar question - So what is a media company?*: http://www.economist.com/node/6794282 (March 19th, 2012).

reshaping the media industry?[3]. These questions illustrate the uncertain status of the media industry back then, still relevant today. In the 1990s some expected the extinction of mass media as it used to be then (Crichton, 1993), while some adopted a more cautious point of view regarding the transition from mass media culture to post mass media, and argued for a change in old media use as we witness a "continuous social and technical change" (Rasmussen, 1999). Following the explosion in adoption of digital computers and the more recent shift toward mobile technologies, media is undoubtedly undergoing exciting transformations. For an exhaustive historical review of the various themes discussed by scholars studying new media, the interested reader could refer to Scolari (2009), which identifies potential areas to be further explored in new media studies. Human-computer interaction, one of the overall focus area of the present thesis, is argued to "*hold an important position in contemporary conversations about digital media*" (Scolari, 2009, p. 959).

In *The language of new media*, Manovich suggests five key principles to distinguish "new" media from the "old" media. These differences that turn old media objects (such as still images, moving images, sound, and text) into new media ones are explained below.

Numerical representation New media objects can be described formally, by mathematical functions, and are subject to manipulation: "media becomes programmable".

Modularity Media objects are collections of autonomous discrete samples (like still images are made of pixels); they can also be combined together to create larger objects (still images can be arrange into a video).

Automation The creative process of new media objects can be partially free from human intervention.

Variability New media objects are "mutable" or "liquid", which means that their reproduction often results in other versions different from the original object (see for instance the *memes* phenomenon described in Dawkins (1976) and Blackmore (2000)).

Transcoding New media objects are composed of a computer layer (the object's structure follows the "established conventions of computers' organization of data") and a cultural layer (the structure is human readable), the merging of which results in "the new computer culture":

> "*a blend of human and computer meanings, of traditional ways human culture modeled the world and computer's own ways to represent it.*"
>
> (Manovich, 2002, p 64)

After introducing what new media is, Manovich goes on debunking myths of what new media is not. Besides arguing for the non-novelty of some new

[3] *What sort of revolution? Both good and bad – but it's too early to say in what proportions*: http://www.economist.com/node/6794256 (March 19th, 2012).

(digital) media attributes (such as random access, resistance to time-induced degradation, or lossless copy), which were already relevant for traditional (analogous) media, the last argument concerning interactivity is of particular interest for this thesis, which is largely concerned with various interactive processes. In Manovich's view, modern media understands interactivity too literally, focusing solely on the physical processes involved when one uses a medium, and ignoring the underlying "*psychological processes of filling-in, hypothesis forming, recall and identification, which are required for us to comprehend any text or image*" (Manovich, 2002, pp. 71-72). In fact, Manovich points out that instead of creating our own personal links between media objects (such as images or sentences), interactive media asks us to follow the links pre-programed by the media's author.

Manovich further argues that the transition from old to new media is a revolutionary change, and that this revolution, "*the shift of all of our culture to computer-mediated forms of production, distribution and communication [...] is arguably more profound than the previous ones*", referring to the advent of printing press and photography, "*and we are just beginning to sense its initial effects*" (Manovich, 2002, p. 43). For Manovich, the synthesis of digital computers and media technologies results in new media, or in his own words, "*graphics, moving images, sounds, shapes, spaces and text which become computable, simply another set of computer data*" (Manovich, 2002, p. 44). The present thesis interprets this synthesis process as digital convergence, and instead of considering media technologies and digital computers as a whole, focuses on television and mobile technologies.

Jakubowicz pointed out other specificities to new media: All media are "new-media-to-be", which supports the argument of a smooth transformation from traditional to new; media can be created and distributed by new entities (e.g. political, economic, non-professionals or new intermediaries); citizen journalism and user generated content (UGC) are part of the new media offer; non-media actors engage in media activities. (Jakubowicz, 2009)

With regard to television, the same hesitations exist between those expecting the TV as we knew it in 2006 to die out by as early as 2012 (Berman et al., 2006), and those arguing for a transformation of TV slower than expected (Jakubowicz, 2010). Common to both viewpoints, television is expected to play a major role in shaping cross-media practices, as argued in Müller (2009). Based on McQuail et al.'s *Communication Theory & Research* (McQuail et al., 2005) and reviewing Foster's potential scenarios for the future of television (Foster, 2007, pp. 24-25), Jakubowicz identifies the three following types of changing processes impacting traditional television. As those three processes are arguably already ongoing, Jakubowicz questions the degree at which they are occurring.

Fundamental "paradigm shift" Content is no longer assembled and distributed by dedicated organizations, nor is the viewer passive.

Fundamental change Content distribution is more individualized but remains under the control of content providers.

Secondary change Jakubowicz cites various examples of such change, from distribution of linear and non-linear content across platforms in a place- and time-shifted way to novel content production methods.

Finally, mobile TV was perceived in 2006 as a logical step in this evolutionary media process. Evaluating near futuristic visions from that time in which mobile TV exemplifies new media becomes relevant based on current development. As an example, the three scenarios suggested in Meyer (2006) for the 2015 European market are shortly reviewed here.

TV in complete freedom Characterized by ubiquitous access to TV services and prominent use of mobile terminals, mobile TV penetration reaches half the European population, turning TV watching into an individual experience.

The age of Egocasting Personalized Internet based TV offerings replaced traditional programmes, and PC Media Centres are common place in heavily connected houses. Mobile TV however fails against podcasting solutions.

The reign of TV portals TV consumption is highly personalized and non-linear. Mobile TV services offer both VOD and broadcast content.

Meyer carefully concludes by anticipating the most likely future of European media to be a combination of the above mentioned scenarios. In light of recent development, especially concerning mobile broadcast television as discussed in the next section, the last two scenarios seem more likely to be realized in the near future.

The European mobile TV ecosystem

In July 2007 the European Commission adopted a mobile TV strategy encouraging the use of DVB-H (Digital Video Broadcasting - Handheld) as the European broadcast mobile TV standard, in order to facilitate the development of mobile television across its members and to grant access to the service by Europeans regardless of their location within the Union (European Commission, 2007, Kotterink et al., 2007). In March 2008, the same Commission endorsed DVB-H as the de facto standard technology to be used in Europe (European Commission, 2008). This expected move was perceived as an attempt to reproduce what happened when the EU adopted the GSM standard, which at the time gave the EU a head start ahead competing markets and a front place on the global mobile telecommunication scene. However the adoption of DVB-H based mobile TV evolved very slowly and eventually came to a stop around 2010. Similarly in the USA, and further illustrating the difficulties encountered by broadcast mobile TV technologies, Qualcomm discontinued its competing technology MediaFLO (Forward Link Only) and associated FLO TV service in early 2011. The following paragraphs summarize the main steps of this unexpected development in Europe.

Successful early trials

In the period 2003-2006, broadcast mobile technologies (among which DMB, DVB-H, MediaFLO, and ISDB)[4] were expected to overtake unicast technologies in terms of adoption and revenues by 2009 (Kaul, 2006). Particularly in Europe, DVB-H was foreseen as the best suited solution for delivering broadcast television to handsets (DVB, 2006, Kaul, 2006). According to the DVB Project office, Europe went through a wave of around 50 trials in various cities[5]. Some countries conducted trials with DVB-H and other technologies. The enthusiasm surrounding these trials is clearly visible from the numerous studies reported in the literature, and is briefly reviewed in the following paragraphs.

Under the lead of Nokia, multiple Finnish cities deployed DVB-H testing networks, which were used as testbeds for several longitudinal user studies. These trials served as case studies for other European countries eager to build on their outcome. The long duration of the Finnish trials allowed extensive user studies to be conducted in order to understand the potential drivers of broadcast mobile TV's anticipated success. One of the first accounts of such large scale trial is reported in Södergård (2003). The comprehensive report informs on popular features of mobile television, typical use situations, preferred content and programming formats, adoption patterns, device usability, and service cost. Moreover, various contexts of use were investigated separately, putting forward context-dependence concerning the choice of content to be watched on mobile devices. Results from a later user trial confirm those findings (Mäki, 2005). In similar studies, usage patterns were discovered in Kaasinen et al. (2009), and motivations for adoption and use were identified in Carlsson & Walden (2007). The findings of these studies are further elaborated on in Section 3.2, in which similar studies conducted in the course of the CAMMP project are presented.

Following the Finnish case, other European countries conducted longitudinal user trials of DVB-H based broadcast mobile TV setups. In 2008 the European Broadcasting Union (EBU) released a report summarizing the status of such trials in 16 European countries and in 2009 the CAMMP project conducted a similar study, focusing on the underlying business models of the various countries involved in the trials (EBU, 2008, Falch et al., 2009). The cases of Italy and Austria are especially interesting as these two countries committed to DVB-H early in order to offer a running service for the 2006 football world cup and the Euro 2008 football tournament, respectively. Benefiting from the popularity of these events, adoption rates were rapidly high, placing the two countries in the forefront of the European mobile TV market. In Germany, Trefzger thoroughly investigated in 2005 end-user expectations toward mobile TV, technological and regulatory prerequisites for its success, the mobile TV value chain and its impact on mobile operators and TV broadcasters, as well as services and pricing models. The study optimistically concludes that "*a converging of the TV and mobile worlds [is] not only feasible but reasonable.*

[4]DMB: Digital Multimedia Broadcasting, mostly used in South Korea; ISDB: Integrated Services Digital Broadcasting, mostly used in Japan and Brazil.

[5]List of DVB-H trials worldwide: http://www.dvb-h.org/services.htm (March 9th, 2012).

[...] Market potential for mobile TV is large, [...] regulatory obstacles are relatively minor, [...] technological obstacles are not very significant [and] consumer interest is high" (Trefzger, 2005, p. 79). Concluding this short review of the initial wave of optimism surrounding the early stages of European mobile broadcast TV, Telenor released in 2007 an in-depth analysis of Mobile TV usage in Norway (Andersen et al., 2007). This report presents usage behaviour, ideas for new services and barriers for use, collected through surveying 1000 mobile TV users. The main conclusions of the study reveal difficulties in terms of user experience provided by the service and pricing models. Most predictions were nevertheless confident that the foreseen challenges would be overcome and the market would rapidly take off, as discussed next.

Confident market previsions

In 2003, mobile TV was expected to flourish and revolutionize the way audiences consume media on the go within a few years. Many scholars and market analysts anticipated mobile broadcast TV to become the new "killer application", as summarized in an article describing potential scenarios for mobile TV services:

> *"Mobile broadcast TV combines the two best-selling consumer products in history - TVs and mobile phones. As a result, Mobile TV applications seem to be a good candidate for the next wireless 'killer application'."*
>
> (Jordan & Schatz, 2006, p. 55)

In an analysis of English and Chinese academic literature about mobile television commissioned by Nokia, Orgad emphasizes the likeability of mobile TV to transform TV experience and its impact on advertising (Orgad, 2006).

Moreover between 2006 and 2011, the number of mobile phone subscribers worldwide more than doubled from 2.5 to over 5.9 billion, which represents 87% of global penetration for mobile phones (ITU, 2011). In Denmark alone, the mobile phone penetration rate reaches 135% of the 16-75 years old population[6]. In terms of mobile video consumption, the agency comScore reported 12.1 million people watching video on mobile devices in 2010 in the EU5 region (UK, Italy, France, Germany, and Spain), including 3.5 million watching broadcast content[7].

In comparison, the global mobile TV market evolved very slowly during this period. In 2006, only seven million handsets capable to deliver mobile TV were in circulation worldwide, mostly present in Eastern Asia (UMTS Forum and GSMA Group, 2008). The mobile TV market was then still in its emerging phase yet many anticipated a huge growth for the years to come.

[6] Danish statistics computed from Danmarks Statistik, www.dst.dk (March 9th, 2012).

[7] comScore: *Video Makes it Big on the Small Screen in Europe*: http://www.comscore.com/Press_Events/Press_Releases/2010/9/Video_Makes_it_Big_on_the_Small_Screen_in_Europe (June 25th, 2012).

In an analysis of a 2005 McKinsey report, the European market is expected to grow to 24€ billion and reach 190 million users in 2015 (Bughin, 2006). Another optimistic study conducted in 2007 by Rethink Research Associates anticipated the number of mobile TV receivers to reach 244 million by 2011 and mobile TV services to be launched in 55 countries worldwide. At the same time, the study predicted Western Europe to lead in revenues the global mobile TV market, with an estimated share of 42% of a foreseen 24$ billion (18€ billion) global mobile broadcasting market[8]. In terms of number of users, The Register reported another study expecting 120 million mobile TV viewers in 40 countries by 2012[9]. Similarly, the organization DigiTAG collected similar statements from diverse industrial and market analytic sources when reviewing the status of the European mobile broadcast TV market in 2006 (Molins, 2006).

Another generally accepted fact at this point in time was the convergence of various communication channels toward the mobile phone. For instance Kivisaari & Luukkainen base their analysis of the Finnish mobile broadcast market on the observation that the mobile phone is at the point of convergence of broadcast media (TV and radio), mobile data (such as Internet), and communication channels (voice, SMS, email). They go on arguing for a small initial investment and a joint effort from the various stakeholders involved in the deployment of mobile broadcast TV networks; a position further argued for in Mvungi (2008). To a certain extent, technology convergence and development strategy unification were visible through the number of mobile TV trials that continued to take place between 2005 and 2007 throughout Europe (Braet & Ballon, 2008, Buchinger et al., 2009). Authors however foresaw a number of constraints to be addressed in order to ensure such success. Despite the growing interest in broadcast mobile TV technologies and services, and obvious expectations after the early successes previously discussed, cautious optimism was then adopted by many scholars who recommended careful analysis of drivers and barriers toward adoption, as discussed next.

Technological, economical and regulatory barriers to deployment and adoption

The slow disappearance of enabling technologies such as DVB-H in the years following the initial enthusiasm surrounding the test campaigns confirmed the difficulties mobile TV development has been facing. The raise and fall of mobile broadcast TV that happened in Europe and especially in its biggest market Italy (Evens & Prario, 2012) is indeed representative of the mobile broadcast TV market in this region. After the promising trials, some commercial successes and its nomination as the European mobile TV standard, the technology was slowly dropped by phone manufacturers and network operators during the 2008-2010 period. More than a lack of interest from consumers, the huge investments required to build the infrastructures supporting DVB-H combined with hesitant business models held back the deployment of the

[8] *Mobile TV will reach 244 million by 2011, says report*, available from The Register: http://www.theregister.co.uk/2007/05/21/mobile_tv_report/ (March 9th, 2012).

[9] *Mobile TV to reach 120 million users by 2012: report*, available from The Register: http://www.theregister.co.uk/2007/09/20/mobile_tv_report/ (March 9th, 2012).

technology and the development of services capable to ensure its long-term success.

From a technology point of view, DVB-H offers features tailored to mobile use requirements, and results from extensive performance measurements conducted in laboratories demonstrated the standard's efficiency, especially in terms of error correction and power saving (Kornfeld, 2004, Faria et al., 2006). However it also presents some limitations that have to be taken into consideration while building services on top of it. An example of such constraint can be found in the conclusions from Bria & Gómez-Barquero (2005), which shows that a cost-efficient development of DVB-H cannot be achieved if high coverage and capacity are targeted. Instead, the authors encourage practitioners to focus on developing adaptive applications on the device implementing data caching and supporting cellular network for point-to-point retransmission. Those results are confirmed by the measurements detailed in Gómez-Barquero & Bria (2005), showing that very high power levels are required at the broadcasting site for achieving indoor coverage for handheld devices. If not carefully considered, this drawback can lead to poor quality of service and thus negatively influence user experience. Moreover, it is argued that the fragmentation of mobile broadcast technologies adopted globally is a barrier to technology adoption in an already fragmented market like Europe (Steen, 2009).

From a user perspective, already in 2005 only few Finnish users of mobile services showed interest in trying out mobile TV in the future (Carlsson et al., 2006), which somehow contradicts similar studies reporting high user interest before trying the service (Trefzger, 2005) and high user satisfaction once market products are available (Jarvenpaa & Loebbecke, 2009). In 2009 the agency Arthur D. Little reported "disappointing subscriber uptake worldwide" and lowered the figures for expected number of subscribers and revenues for 2011 to 140 million and $4-12 billion, respectively (Taga et al., 2009). Such a large stretch in expected revenues illustrates the market scepticism and hesitations. For Flemish mobile TV users, such service is seen as a "commodity-device", to be used when no other TV is available, to catch up with news and 'light' information (Schuurman et al., 2009). Even more recently, the conclusion from an extensive analysis of the intent of acquiring mobile TV in the Netherlands summarizes well these uncertain and deceiving previsions concerning user adoption: "*Mobile TV has potential. but isn't going to be the killer app as many predicted*" (Bouwman et al., 2011, p. 193).

In addition to technological and regulatory issues (Curwen & Whalley, 2008), many consider the biggest challenge mobile broadcast TV faces to be the identification of a business model suitable for all actors of the value chain that can absorb the high infrastructure costs of setting up the dedicated distribution network (Bria et al., 2007, EBU, 2008). The last few years proved that the combination of these barriers prevented the expected take off of mobile broadcast TV, leading most European players to withdraw their engagement and stop services.

Nevertheless, in a positive note from 2011, the research group Rethink carefully suggests that mobile TV could be coming back to the front scene thanks to either a dedicated technology based on an existing widely used format (such as DVB-T2), or more likely to non-dedicated technologies (WiFi or LTE)[10]. As de Renesse puts it:

> *"As originally defined and designed (linear TV streaming on handsets), mobile TV is on the brink of extinction.Yet, demand for video content on mobile is stronger than ever. Mobile TV will have to be reborn and transformed in terms of format, content and business model."*
>
> (de Renesse, 2011, p. 2)

This stance on new media echoes well Rasmussen's prediction:

> *"There will be no 'killer application', no wonder-medium that makes all other media redundant."*
>
> (Rasmussen, 1999, p. 153)

Even though this PhD project is not focused solely on mobile TV, it originated at a time when a national deployment of DVB-H based broadcast mobile television network was expected in Denmark. The focus of the work however slightly drifted toward a more general concern of converged media, encompassing functions omitted in early definitions of mobile television. Still, this thesis reports on early trials of such services, and informs user expectations towards them as well as technology-related constraints that may hinder enjoyable user experiences if overlooked by design teams.

Mobile media in East Asia

The purpose of my stay abroad was not only to conduct research in a different institution and learn about disciplines that complement the engineering dimension of this thesis, but also to experience a different market and try to understand its characteristics, challenges and cultural specificities. In that sense Japan provided an ideal environment due to its high level of technological development, the particular organization of its industrial actors and the cultural reasons behind these. Thanks to various interviews conducted throughout my stay and a brief overview of recent literature, the following paragraphs offer a short summary of the current status of East Asian new media.

Starting with the country hosting my stay abroad, it is broadly acknowledged that Japan is one of the world leaders in terms of information and communication technologies (ICTs), and especially when it comes to mobile communications. Third generation mobile technologies were launched first

[10] *Faultine: Son of DVB-H comes up for air - in mobile TV allergic Europe*, available from Enterprise Innovator: http://enterpriseinnovator.com/index.php?articleID=16296&sectionID=269 (March 9th, 2012).

in Japan, and the Japanese quickly adopted the mobile phone to mediate their personal and professional lives (Srivastava, 2004). In *Personal, Portable, Pedestrian*, Ito et al. review the social, cultural and historical elements of the particular relationship between the Japanese and mobile phones. This peculiarity is already present in the term "keitai", used to refer to mobile phones as a "*snug and intimate technosocial tethering, a personal device supporting communications that are a constant, lightweight, and mundane presence in everyday life*" (Ito et al., 2005, p. 1).

In a comparison of radio and television use in Japan, Germany and the UK, Heinze identified the following discrepancies between the Japanese and European markets: 1) Television is far more used than radio in Japan, compared to Germany and the UK, 2) A considerable gender gap in media habits exist in Japan, reflecting the country's gendered structure of daily work and life, and 3) Media use increases with age more significantly in Japan than in Europe (Heinze, 2011). Additionally, mobile Internet use is highly developed in Japan since the early introduction of supporting technologies in 1999 (Ishii, 2004). This behaviour is expected to grow in the future, a prediction supported by Funk (2005). It should be noted that even though mobile Internet is highly popular in the entire East Asian region, the adoption by the masses in Japan is not representative of the East Asian region, as uncovered in Kim et al. (2004). Indeed, despite a growing regionalism in East Asia, each market preserves its historical, social, economical and political specificities with regards to new media practices, as exemplified by the differences in media usage by Japanese and Taiwanese youth (Ishii & Wu, 2006).

The following is mostly based on the interview of Yonnie Kim (Kim, 2010), self-described as *media researcher and ethnographer on digital media*, graduate student at the University of Tokyo Interfaculty Initiative in Information studies. Prior to her enrolment in the doctoral program, she had been working for various Korean media related firms and was in particular in charge of OhMyNews International[11], an international platform for citizen journalists (netizens). Arguing that it is not the role of media or technology to change society, she investigates the integration of new media in East Asian societies not by directly observing how society changes but rather by studying the impact media technology has on the society it engages in. She exemplifies her stance by noting that if the way people communicate nowadays differs from that of a decade ago, the reasons why people communicate remain the same. As a trained and experienced journalist, she expected the switch from print to online format to create a democratic open space that would open up the audience mind by offering a wider selection of content. However she now realizes that this maybe utopian scenario has failed to happen, the new platforms being used instead to reinforce one's opinions and criticize others'.

Media creation in East Asia should be understood culturally and historically. For instance, even if today's Korean media market is stable, until quite recently it was unhealthy and difficult to maintain financially, and thus in need for a way to survive. A new media model was introduced, inspired

[11] http://international.ohmynews.com/ (September 26th, 2011).

from the USA in the early 2000s, offering content for free and supporting user generated content (UGC). In 2005, the early days of DMB-based Korean mobile TV seemed quite uncertain due to the socio-technical challenges laying ahead (Shin, 2006). Nevertheless, socio-cultural factors quickly turned mobile broadcast TV into a success (Kwon & Chon, 2009, Kim, 2011). The mixture of top-down and bottom-up approach adopted in South Korea contrasts with the Japanese subscription based model, top-down and little prone to acknowledge the need for a necessary change in order to adapt to the new market. Moreover, higher social mobility in China and South Korea offers more opportunities for technology development, and even though huge differences remain within the country, large Chinese urban areas have caught up with South Korea in terms of technology use. Further illustrating regional discrepancies when dealing with new media, the regulation of new media technology development in Japan, Hong Kong and South Korea has been studies and reported in Kwak (2007). Focusing on the pay television industry, Kwak demonstrates that although all three countries have undergone very strong regulatory interventions under strong political influence in the past two decades, they have each adopted distinct strategies, especially when it comes to governmental participation. The study concludes that the deregulations witnessed in Japan and South Korea were ineffective at incorporating all types of pay TV, due to misalignment of the state's and broadcasters' interests. Noble nevertheless points out that in Japan, fast technological advances led to "extraordinary rapid market opening", under political strong influence even by conservative ministries (Noble, 2000). This tendency to react efficiently to technological evolution is not confined to television. Broadband Internet access also underwent dramatic changes in the early 2000s leading to an explosion in adoption (by a factor 7 between 2001 and 2004), following the Japanese government's push to ensure high broadband penetration (Kwak, 2007).

Also specific to Japan, technological nationalism seems to prevent mobile phone manufacturers to sell their products outside Japan, despite these mobile phones being the "output of the Japanese dream", as Kim phrases it. The current division between smartphones (represented by the iPhone) and the *galakei* (which stands for "Galapagos keitai" and refers to the mobile phones made in Japan for the Japanese market), illustrates well the current status of the Japanese mobile market and its tendency to "lead without followers" (Kushida, 2011). Firstly, these typical Japanese phones, despite their higher technological advances, are loosing market shares against their smartphone rivals, more appealing in terms of user experience. Secondly, after an arguably slow start in Japan when it launched in June 2008, the iPhone is now extremely popular, as illustrated by the recent success of the models 3GS, 4 and 4S, as

reported by BCN Rankings[12], Mobile in Japan[13], CNET[14] and Tech in Asia[15]. Technological nationalism can also be found in South Korea and China, even though in the Korean case, international competition also drives national phone manufacturers.

If Asians are already used to consume media on their mobile phone, the context of use remains a critical issue for technology developers and content providers: It creates both opportunities and barriers. For instance, since it is socially unacceptable to display a loud behaviour when using Tokyo's metro, commuters spend their travelling time reading (books and e-books), gaming (on portable gaming devices or mobile phones) or chatting with friends via mobile email. This attitude however is region-specific, and does not apply to South Korea or even southern Japan. Nevertheless, reading constitutes a key activity in Japanese transports. E-books are widely available and very popular. Furthermore, a new genre of novels has appeared in the last few years, to be read exclusively on mobile phones. The layout of the stories is vertical to fit the screen, aerie for easy reading, and the writing style is deliberately kept simple. Targeted mostly at a young audience, the *keitai shousetsu*[16] or "cell phone novels" encourage many teenagers and young adults to engage in writing and publishing their stories through dedicated online platforms, which generate revenues for the authors. (Arthy, 2010)

These practices, despite their cultural specificities, should be used as examples and learnt from when designing converged media services for other regions. For instance, reading on mobile devices during transportation time is a usual practice among commuters globally, and thus much could be learned by studying how the Japanese cope with technological and cultural constraints when reading or writing cell phone novels. Similarly, consuming videos on mobile phones is nowadays a regular activity in Korean public transportation systems, as well as playing video games in the Japanese metros and trains. Again, if cultural differences may not allow for reproducing the same scheme of mobile media inclusion into people's life in Europe, more careful studies of how the East Asian markets developed in the past decade, especially in terms of business models and regulation, should help better understand how to overcome the barriers that currently prevent a wide deployment of services much expected by potential end users.

[12] BCN Rankings, September 08th, 2011. iPhone 3Gから3GS/4まで、iPhoneのこれまでの売れ行きを振り返る [*From 3G to 3GS/4, looking back at iPhone sales so far*]: http://bcnranking.jp/news/1109/110908_20906.html (in Japanese, May 12th, 2012).

[13] Mobile in Japan, October 25th, 2011. *The iPhone 4S Crushes the Competition in Japan Sales Rankings*: http://mobileinjapan.com/2011/10/25/the-iphone-4s-crushes-the-competition-in-japan-sales-rankings/ (May 12th, 2012).

[14] CNET, March 14th, 2012. *Apple tops Japanese smartphone market for first time*: http://reviews.cnet.com/8301-19512_7-57397688-233/apple-tops-japanese-smartphone-market-for-first-time/ (May 12th, 2012).

[15] Tech in Asia, May 11th, 2012: *iPhone was Japan's Top Smartphone for 2011, But Android Still Dominant OS by Far*: http://www.techinasia.com/apple-top-smartphone-in-japan/ (May 12th, 2012).

[16] 携帯小説 (Cell phone novel): http://en.wikipedia.org/wiki/Mobile_phone_novel (March 19th, 2012).

Interactive TV

Interactive television is another case of anticipated revolution that has yet to come. Citing Carey's *Interactive Television Puzzle* and his later extensive review of interactive television projects and services, Jensen notes that interactive television (iTV) has been around since the early days of television. Arguably, television was originally intended to implement a two way communication technology, but it has been quickly eclipsed by the emergence of the one-way mass media, ubiquitous in today's homes (Carey, 1994, 1996, Jensen, 2008b). Despite a large number of trials throughout the past fifty years (see for instance Carey (1996) for a review of trials from the 1950s to the late 1990s, and Tuomi (2009) for a review of later trials), interactive TV services never really took off, due to technological inappropriateness and competing technologies, lack of supportive business model and of content with added value (Jensen, 2008b). A famous and successful attempt at bringing interactive television to the homes is the *Hugo* franchise. Launched in Denmark in 1990, the game was played via telephone line. Originally the participants used vocal commands to direct a blind-folded actor who would control the Hugo character via a joystick. Later, Hugo was controlled directly by participants calling in and pressing keys on their telephone. The game grew popular outside Denmark and eventually aired in up to 43 countries worldwide. The franchise also led to more than 30 video games for computers, consoles, web browsers and mobile devices[17].

Despite such encouraging stories, as with mobile TV Jensen suggests that "*there is nothing that indicates that suddenly it will be managed to find the irresistible, magical killer application that can power a swift mass proliferation of the technology*" (Jensen, 2008b, p. 10). Nevertheless, iTV is already present in various forms, and technological advances together with broadcasters' interest as discussed in Section 2.3 allows for being optimistic in the future development of iTV. It should also be considered that shifts in practice with popular technology takes time, and redefining use patterns of a ubiquitous media such as television cannot happen overnight. More than focusing on the reasons why iTV has not been adopted by the masses yet, Slot (2007) suggests looking at how the user-producer relation is reshaping, and considering how other industries (such as music) have dealt with the advent of new practices. This would allow discovering and implementing services beneficial to all the stakeholders of the TV value chain.

Defining the *i* in *iTV*

In *Interactive Television - TV of the Future or the Future of TV*, Jensen defines interactivity as "*a measure of a media's potential ability to let the user exert an influence on the content and / or form of the mediated communication*"(Jensen, 1999, p. 59), and identifies four dimensions to categorize interactive media. These dimensions follow the information traffic patterns defined in Bordewijk

[17]The latest version of Hugo is available from Apple's App store, the Android market and Nokia's Ovi Store: http://www.hugo-net.com/ (April 30th, 2012).

& Kaam (1986): *transmission*, *consultation*, *conversation*, and *registration*, and are based on whether an information provider or the consumers produce information and control its distribution. More recently Jensen revisited his early definition of interactive TV by introducing three additional dichotomies to help better categorize the plethora of media types available to end users nowadays:

Media form / User mode Media form differentiates mainstream media from social media, while User mode separates passive from active users.

Media creation / Editing This division refers to whether media professionals or end users create and edit the content.

Shifting Content can be consumed fixed or shifted with regard to space, time, and its format.

In Pavlik & McIntosh (2010), interactivity includes the following three elements: 1) a dialogue occurs between a human and a computer programme, 2) the dialogue affects the content of the interaction, and 3) the audience controls what content it sees and when it sees it (Pavlik & McIntosh, 2010, pp. 212-213). Establishing a "true dialogue" between two or more people or between people and technology is crucial for a media to be called interactive. This aspect of interactivity complements Jensen's focus on control; put together this characterises how interactive television systems are understood in this thesis.

Interactive TV can take many forms, as listed in Jensen (2005): electronic program guides (EPGs), enhanced TV, content-on-demand, personalized TV, Internet@TV, interactive advertising, t-commerce, or games and betting. In accordance to previous analyses, Jensen expects successful interactive programmes to be targeted at audiences with short attention span, relying on quick decisions and instant gratification. Such programmes include EPGs, interactive commercials and t-commerce, news and weather programming, sports, as well as talkshows and games. Specifically, user requirements for interactive news application have been established in Brecht & Kunert (2005), and prototypes of possible future services have been successfully implemented and tested with potential end users (see for instance *MyNewsMyWay* (Lindstedt et al., 2009) and *Rich News* (Dowman et al., 2005)). Games have also been investigated via longitudinal testing of prototypes, such as *The Footprints of Power*, an auction-based multiplayer game in which the actions of players were reflected in the show associated with the game.

In an attempt to classify the many possible kinds of iTV systems, van Dijk et al. differentiate between "enhanced television" (low level of interactivity) and "real" interactive television. The authors proposed a classification of iTV system based on the viewers-users continuum depicted in Table 1.1. The authors also suggest the following four dimensions of interactivity iTV systems should integrate (van Dijk et al., 2003).

'Multilateralness' iTV involves at least two actors (a supplier and a user) who take turn to perform two actions (send and receive) in an alternating exchange of content.

Synchronicity user actions are reflected fast, providing a sense of continuous communication.

Control viewers decide the *what*, *when* and *how* of their TV experience.

Understanding requires all actors of the iTV system to know the meaning of all actions performed in the system, for instance when content producers integrate user input to their content as they are submitted.

Applying this classification scheme, van Dijk et al. distinguishes applications belonging to digital television from actual interactive applications. The electronic program guide (EPG) for instance, is not considered an iTV service, while customization (e.g. choice of camera angle), participation in live programmes and concurrent discussion about programmes are examples of iTV services.

Table 1.1: van Dijk et al. (2003)'s *Continuum of indications of interactivity in definitions of ITV*.

Actor indication	Activity indication	Activities concerned
Users	Exchanging, Interacting	Communicating
↕	Acting	Producing information
	Reacting	Choosing from menus, making transactions
Viewers	Zapping	Choosing programmes and channels

When it comes to interacting with the iTV content, Vatavu suggests a shift in controlling interfaces from vertical to horizontal, the remote control being expected to be replaced by a mixture of natural interfaces relying on speech, gestures and body movements, and tangible interfaces via the use of everyday objects (Vatavu, 2010). If these creative scenarios seem plausible, it is believed in this thesis that second screen setups are more likely to be adopted to control TV content and access interactive services. This issue will be addressed in details in Chapter 3.3.

Concluding an essay on the domestication of media technology and the redefinition of television experiences, Christensen calls for change at three levels: 1) structural (programme formats should better address audiences), 2) motivational (added value for the audience should be explicit), and 3) technological (operating the medium should be easy) . This thesis will mostly address the second level of change identified in Christensen (2002) and to a lesser extent the third level, as it will not only strive for identifying how audiences perceive the newest developments of converged media and informing the future of such services, but also provide insights on specific usability issues with potential services.

Mobile media contexts

The ubiquitous nature of mobile phones and mobile applications has led to the emergence of new contexts in which audiences consume media. These mobile contexts are arguably hard to identify and classify, due to their intrinsic relationship with people's life. Situations in which one may consume media on a mobile device are often ad-hoc, activity dependent, and go easily unnoticed as they are subtly embedded into the flow of everyday occupations. To understand what being mobile entails, one needs to start by understanding what context is. Widely cited, Dey et al. defined context as follows.

> *"Any information that can be used to characterize the situation of entities (i.e. whether a person, place or object) that are considered relevant to the interaction between a user and an application, including the user and the application themselves. Context is typically the location, identity and state of people, groups and computational and physical objects"*
>
> (Dey et al., 2001, p. 107)

.

This broad definition tends to encourages mobile researchers to harness all possible pieces of information relevant to the interaction between an application and its user in order to try and decipher what people are doing when, where, how and with who. Alternatively, it can mean that any collected information relevant to the situation in which user-application interactions happen, provides useful clues as to infer the situation's context. However, the issue of relevancy in the previous definition leaves room for interpretation. Abowd et al. clarifies this point when defining a context-aware application:

> *"A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task."*
>
> (Abowd et al., 1999, p. 309)

Tackling this issue, Paul Dourish more recently revisited earlier definitions of context by contrasting two possible stances: Context as a representational problem; and Context as a interactional problem (Dourish, 2004). For what concerns the representation perspective, Dourish identified four assumptions in earlier literature: 1) Context is a form of information (it can be encoded and represented); 2) Context is delineable (what is context and what is not for an application can be determined in advance); 3) Context is stable (a context instance does not vary from application to application); and 4) Context and activity are separable (no interaction between activity and context are considered). Surprisingly, this last comment seems to contradict previous analysis of the impact of context on specific activities such as mobile work Wigelius & Väätäjä (2009), and user experience in general (Coursaris & Kim, 2006, p 24). Dourish observes that *capturing*, *representing*, and *modelling* context are a primary concern for researchers interested in context-aware applications.

Arguing that the intellectual tradition behind the drive to represent context is in conflict with its practical application, Dourish then proposes an alternative perspective on the four above-mentioned assumptions, according to which context is perceived as "*an achievement, rather than an observation; an outcome, rather than a premise*" (Dourish, 2004, p. 25):

- Context is not information but "contextuality is a relational property" between objects or activities, putting the accent on the relevance of context to a particular activity.
- Context is not defined in advance but "the scope of contextual features is defined dynamically", living room for varying levels of relevance within an activity.
- Instead of being stable from an activity to another, "context is an occasional property", which allows tailoring context to specific applications.
- Perhaps most importantly, context and activity are not considered separately, but "context arises from the activity".

This understanding of context, as an evolving framework emerging from the activity users are taking part in while interacting (with other people or with an application), renders the identification of such context tedious. Trying to understand mobile contexts in urban areas, Tamminen et al. identified five characteristics specific to mobility, often reoccurring and sufficiently factual to be considered when developing context-aware applications (Tamminen et al., 2004):

Situational acts within planned ones refers to the unplanned, ad hoc "minor-scale activities" that happen while performing a main task (for instance navigating from a place to another).

Claiming personal and group spaces is a universal need and happens in the presence of others. It signifies the participation in or the distancing from a location-dependent social activity.

Social solutions to problems in navigation refer to the renegotiation of social activities due to unplanned schedule changes, which happen frequently when navigating from a place to another.

Temporal tensions often arise when moving around. This leads the "normal proceeding" of the activity to be accelerated, slowed down, or even stopped, calling for adapting the activity and potentially impacting other spatially or temporally dependent activities.

Multitasking while navigating in a urban environment requires constant monitoring of the environment, redistribution of cognitive resources, and management of turntaking with other actors involved in the activity at hand.

Keeping in mind Dourish's arguments for a non-predictable, non-rigid framework to context, it is hard to properly understand how context impacts mobile user interaction without turning to sensor-based or ethnography-based observation methods. Concerning the former, if a plethora of contextual sensors exists (see for instance the list maintained by the European Open

Living Lab's Knowledge Center[18]), not all are relevant to nor easily implementable in mobile applications. A tempting approach when considering mobile context is to overestimate the role location plays in defining context. In fact, location is quite easy to deduce from a number of sensors (such as GPS, network access points, accelerometer), however "*ultra-mobile computing [...] can significantly benefit from a wider notion of context*" (Schmidt et al., 1999, p. 893). This understanding of context has been accepted early among mobile HCI researchers, and has been tackled in recent implementations of context capturing frameworks and context-aware applications. Nevertheless, location is a rather strong first contextual indicator, which can help identify meaningful places. As an example, the work by Nurmi & Koolwaaij, Zhou et al., Farrahi & Gatica-Perez and Nurmi & Bhattacharya illustrates that location can accurately indicate places holding special signification for users, or otherwise being interesting from a research perspective (Nurmi & Koolwaaij, 2006, Zhou et al., 2007, Farrahi & Gatica-Perez, 2008, Nurmi & Bhattacharya, 2008). Furthermore, Jensen proposed *RECON*, a framework and tools for collecting and using virtually any contextual data from mobile phones remotely and autonomously (Jensen, 2011a). Other examples of such tools include *ContextPhone* (Raento et al., 2005), *MyExperience* (Froehlich et al., 2007) and *Nodobo* (Bell et al., 2011).

Ethnographic studies are another mean of informing mobile phone contexts, and a large number have been reported in the literature. For instance reports of ethnographic explorations revisited the definition of mobilities from an aesthetics point of view: Brewer et al. (2008) asked what it means to be mobile in two specific public transportation settings and identified design opportunities. Further exploring busy urban environments, Dourish et al. (2007) argues for a plural definition of mobilities, complex and culturally rooted. Other ethnographic studies focused on specific aspects of mobile lives, such as dealing with the concept of access anywhere, anytime (Perry et al., 2001), the disappearing boundaries between work and non-work communication activities during the day (Hislop & Axtell, 2011) or the practice of "homing" (as in creating a home outside the home) in extremely mobile lifestyles (Petersen et al., 2010). Concerning media use, O'Hara et al. (2007) explores the contextual diversity of typical use situations and motivations through a three-week diary study augmented by in-depth interviews of subjects using devices like iPods, Playstation Portables (PSPs), Archos media players, iPAQs and video enabled mobile phones for handling video content in their everyday lives. O'Hara et al. identified the following four overall categories of usage contexts.

Individual viewing Solitary viewing of video content was the most predominantly identified form of usage in O'Hara et al. (2007). It could be imagined that this form of mobile video consumption primarily would take place in situations where the user was alone. However, many episodes of individual viewing did in fact take place in public places where other people were around and lead to the following sub-categorization of individual viewing:

[18]List of contextual sensors maintained by the European Open Living Lab's Knowledge Center: http://knowledgecenter.openlivinglabs.eu/learn/sensors (April 27th, 2012).

1. Managing solitude
   Users sometimes view mobile video as a mean of managing solitude, for example when dining alone in a cafeteria. Potential situations of social discomfort could in this way be turned into situations in which the user appears purposeful rather than alone.
2. Disengaging from others
   Some users watch mobile video in order to avoid possibilities of social contact or control the acoustic environment (e.g. desiring a private sphere when travelling with other people in a confined space).
3. Managing transitions between spaces
   Users sometimes watch mobile video content when transitioning between spaces (e.g. standing at the bus stop waiting for the bus to arrive). Naturally, this requires a split attention between the surroundings and the video content leading users to prefer to "throw away" content that can easily be interrupted. Such situations of killing time by watching mobile video content were already envisioned by users in Repo et al. (2004) and Södergård (2003). In Oksman et al. (2008), test users still considered mobile content to be most useful while being on the move or otherwise unattainable by regular media.

Coordinating mobile experiences with family life With regards to family life commitments and content-related preferences the following two sub-categories of coordinated viewing of mobile content were identified:

1. Juggling commitments
   People sometimes use their mobile devices for time-shifting video content allowing them to deal with family related commitments without sacrificing time specific airings of video material.
2. Coordinating content with family
   Based on content related preferences users sometimes coordinate the viewing of video content with other family members. Thus, in cases of equal preferences video content was watched together with family members contributing to the social atmosphere. Conversely, in cases of conflicting preferences the use of mobile devices allow easy solitary viewing of content that would otherwise be impossible to view together.

Watching at home For some of the users, watching video content on their mobile devices at home is quite common despite the availability of more suitable devices (i.e. with larger screens and better sound equipment) as this enables greater flexibility in terms of physical placement. Thus, by using mobile devices the users can stay within the vicinity of other family members (i.e. social context) when watching video content while still maintaining a degree of separateness. Naturally, solitary watching of video content is also carried out at home. For this purpose, the small form factor of the mobile devices is a clear advantage as it relieves the users from having to adapt to static setups (e.g. bedroom TVs when watching video content in bed). In Schuurman et al. (2011) it was in fact

found that most viewing of mobile TV occurred at home - especially in living rooms, bedrooms and kitchens.

Sharing the experience Despite practical issues such as limited viewing angles and lack of internal loudspeakers the users often share the viewing of video content with other people. Two subcategories of such experience sharing were found:

1. Watching together
   Rather than just passing time some users enact their friendships through the joint viewing of video content by discussing content, preferences, etc. Other users express their belonging to specific groups or communities by sharing specific types of content, or use the video content as a way of engaging in conversation.
2. Showing video to others
   Some store video content on their mobile devices for the purpose of showing this to other people as a starting point for discussions or for generating humor. Others use video content on their mobile device as documentation for experiences that they would like to share with other people (e.g. holiday trips). In Oksman et al. (2008) this kind of social interaction was however found to be decreasing over time (i.e. after the initial demonstration phase).

It should be noted that these findings are valid cross-culturally to a certain extent, even though some cultural differences remains for instance between Japan and the Scandinavian countries. For instance when it comes to mobile phone use in public, Baron & af Segerstad (2010) confirms prior findings that the Japanese are significantly more reticent to talk during transportation and more bothered by others' conversations in public than Swedes. Additionally, Campbell (2007) notes that the rating of public places considered acceptable to have mobile phone mediated conversation differs more significantly in Japan than in Sweden. Furthermore, the Japanese display a more positive attitude toward accessing news on mobile phones than Swedes, who are however willing to pay more to access the content (Westlund, 2010).

Based on the findings presented above, it can be noticed that transportation time and home are two contexts of primary importance when studying mobile media consumption. The home context is particularly interesting for the research documented in this thesis, as it allows investigating media multitasking and second screen services, two concepts introduced and further explored throughout the user experiments reported in Chapter 3. Additionally, in a recent review of "locative media", Bilandzic & Foth (2012) stressed the need for focusing on methods and design principles when studying spatial interactions and experiences. The present thesis will contribute to the former point in Part II, which introduces and discusses the user research strategies put into practice in Chapter 3.

1.2 Research questions and methodological background

Research questions

The following chapters of the thesis investigate the above-mentioned topics in two separate parts. More specifically, Part I explores the issue of convergence, first theoretically from the perspective of various stakeholders of the new media value chain, and then empirically through a range of user studies. Then Part II argues for a multi-disciplinary inspired user research strategy to explore converged media from the consumer perspective. In summary, this thesis aims at answering the following research questions.

I. What are the current and near future trends in converged media, seen from the perspective of Danish and Japanese media consumers?
In particular, the following sub-questions will be tackled in Part I:

   a) How the technological and cultural aspects of media convergence affect broadcasters' content distribution strategies and end users' consumption practices?

   b) How do Danish and Japanese media consumers perceive the convergence of television and mobile technologies, and what are the opportunities and challenges for wide user adoption of services resulting from such convergence?

II. How to optimize the evaluation of user experience with converged media through a mixture of qualitative and quantitative methods in the context of a 4-year platform project?
Part II will investigate this issue and the following related sub-questions:

   a) How to discover personal stories related to media practices in multi-cultural settings and with tight time constraints?

   b) How to ensure cost efficiency when addressing a wide range of issues related to user experience with converging media?

These two overall themes and related sub-questions are explored separately following different approaches: The first set of questions is addressed through a theoretical discussion introducing the state-of-the-art research from recent literature review, expert interviews, and a user survey. Then a practical section complements this discussion by reporting on a selection of user studies. The second set of questions is investigated through the lenses of these user studies, the methodology of which are scrutinized, and their benefits evaluated relatively to their cost. Overall, the research questions and related sub-research questions are answered in conclusion of the dissertation, in the light of both the theoretical discussions and practical analyses. Nevertheless, the sub-research questions are tackled throughout the dissertation as follows: Chapter 2 supports answering sub-research question II.a, Chapter 3 sub-research question I.b, Chapter 5 and to a certain extent Chapter 6 sub-research question II.a, and finally Section 8.3 supports answering sub-research question II.b. The following paragraphs introduce the research frameworks that influenced this thesis.

Studying New Media

My stay at The University of Tokyo made me realize the importance of considering socio-historical factors when studying new media. In an interview about his various research activities, Mizukoshi-sensei explained how media should be treated as an organic ecosystem, and that media literacy's goal is to establish good basis for such media ecosystem, avoiding propaganda and enabling freedom of expression. In his work, Mizukoshi-sensei considers three dimensions of media literacy: 1) the ability to understand the technical aspects of media creation, 2) the ability to critically receive information, and 3) the ability to distribute expression/information. This scheme applies to laypersons as much as to media professionals, although with varying ratio of each dimension.

On media use in Japan, Mizukoshi-sensei notes that television still greatly influences people, while mobile phones represent cutting edge technology. Before the introduction of the iPhone, Japan had a 10 years history of mobile Internet, and recent studies show that youngsters reduce their Internet connection via PCs and laptops and instead use their mobile phone to stay connected. In Japan it is thus impossible to disconnect Internet use to mobile use. The relationship between television and mobile is a personal matter and should be supported by a flexible ecosystem allowing access to content at the discretion of the user. TV and mobile need to rely on a symbiotic relationship as they are both powerful media tools. Therefore they need a social framework in order for the outcome of their combination to be positive for users. Mobile / TV convergence can support physical and remote social practices, but there is an information gap between the poor and the rich, and this gap increases over time.

Reflecting on the role of media during and after the March 11th, 2011 disaster which occurred a month prior to the interview, Mizukoshi-sensei observed that national and international mass media covered the event in a biased way, searching for "big numbers" and impressive stories. However audiences quickly and naturally shifted their attention to stories emerging from local communities. During the crisis mobile phones acted not only as a communication tool (in fact in some areas there were no electricity at the nearby network broadcast stations), but also as an entertainment platform so people touched by the tragedy could watch videos, take and share photos. The tragic event underlined the role of photos in sharing personal memories and identity. Digital storytelling could support this by forming memory archives. Mizukoshi-sensei's research on the reshaping of media literacy through mobile via participatory workshops is illustrated in Mizukoshi et al. (2005).

Media ecology as an approach to media study

This section intends to provide a rapid overview of the field of study that encourages researchers to consider media not only from its content and impact on individuals but from the perspective of the symbiotic interactions with its cultural environment (further on referred to as an ecosystem) in which media is generated and consumed. The intention is neither to review the field

of media ecology extensively nor discuss the semantics of its definition and various interpretations. Instead, this section places the study of converged mobile media in the communication study framework by introducing an interdisciplinary approach to media studies, as taken by western scholars since the early 20th century. For a deeper insight on the various founders and influencers of the media ecology tradition, interested readers could refer to Lum (2006). Finally, readers interested in the scholar and formal roots of media ecology should refer to Strate (2004) (for a mostly American perspective) and to Goddard & Parikka (2011) for a more European centric overview.

Media ecology is an interdisciplinary approach to communication studies that first appeared in the work of North American scholars in the early 20th century. In his 1934's *Technics and Civilization*, Lewis Mumford started investigating the interplay of "technics" (Mumford uses the term in a broad sense that encompasses technology and craftsmanship) and the societies that use them (Mumford, 1934). Considered among the first philosophers of technology, he argued for studying technologies from the cultural context surrounding their creation and use. Even though Mumford did not explicitly work on media, his reflections on the influences technology and society have on each other are considered the foundation of the media ecology approach. It influenced later philosophers and academics to consider media not only as a result of society advances but also as an active participant and determinant of these.

Marshall McLuhan helped democratizing the media ecology approach from the 1960s on. In *Understanding Media: The Extensions of Man* first published in 1964, he argues that media (which term he interchanges with medium and technology) should be studied not from its content, but from its impact on culture and society. By stating that "*the medium is the message*" (McLuhan, 1964a, p. 7), McLuhan argues that the medium (an extension of ourselves) allows a "change of scale or pace or pattern" (the message). The communication studies should thus focus on the impact technology or media has on societies instead of the content it carries. As an example of his theory, McLuhan points out that the effects of mechanization on society occur regardless of the product manufactured. Although disputed and sometimes proven wrong in the light of how media evolved since the book's publication, the ideas developed in *Understanding Media* have remarkably predicted some technological advancements such as cable television and Internet. As an example of how resonant some of his ideas (or probes) were with how today's societies are interrelated, McLuhan observed how electrical networks turned the globe into a "Global village", and coined the term "surfing" as how to navigate through an heterogeneous body of knowledge in a rapid, irregular and multidirectional movement. McLuhan has nevertheless been charged with embracing media determinism, and focusing on the technological side of communication and neglecting the relations of power that shape todays media. Acclaimed or criticized, the iconic member of the Toronto School of communication theory greatly contributed to the early development of media ecology and inspired many future technology philosophers and scholars throughout the world.

Media ecology has been later formalized by McLuhan's follower, Neil Postman who defined the field as follows.

> "*Media ecology is the study of media as environments. [It] looks into the matter of how media of communication affect human perception, understanding, feeling, and value; and how our interaction with media facilitates or impedes our chances of survival. The word ecology implies the study of environments: their structure, content, and impact on people.*"
>
> (Postman, 1970, p. 161)

In his writings, Postman offers a pessimistic view of the impact media, and especially television, has on society. His negative stance toward the medium is particularly visible in *Amusing ourselves to death*, in which the author criticizes television for turning all its content into entertainment, and thus depriving the audience from its right to access serious information. For Postman, the problem comes less from the presence of entertaining content on television than from its massive volume, which drowns informative content into "a sea of irrelevance" (Postman, 1970). Later in *Technopoly: The Surrender of Culture to Technology*, Postman considers computers as the near-perfect example of technology supporting Technopoly, which he defines as a society based on the "*submission of all forms of cultural life to the sovereignty of technique and technology*" (Postman, 1992, p. 52). The United States are, for Postman the only country which has become a Technopoly, which surrendered to a blind faith in science and technology, and collects information not guided by a purpose but for the sake of it only. Fighting this trend as an academic, Postman pursued the goal of providing students with the historical, sociological, and psychological capabilities of "*[using] technology and not being used by it*"[19].

The aforementioned definition of media ecology has recently been reformulated by Lance Strate when inaugurating the Media Ecology Association in 1999. Strate introduced media ecology as "*the study of media environments, the idea that technology and techniques, modes of information and codes of communication play a leading role in human affairs*" (Strate, 1999, p .1). This definition, which summarizes the American perspective on the research topic, differs however from the European view.

The European approach to media ecology disagrees with the use of the term ecology as environment, as explained by Matthew Fuller in its introduction to *Media ecologies: materialist energies in art and technoculture* (Fuller, 2005). Instead, the European stance on media ecology considers media from its complex political organization. European media ecologists such as Jacques Ellul share some ideas with their American colleagues, but promote a somehow more social approach to media studies. For instance in *The technological society*, Ellul questions replacing moral values by technical ones in modern society (Ellul, 1964), and in *Propaganda: the formation of men's attitudes* he expresses his

[19] Neil Postman's answering the audience of PBS' NewsHour in 1996: http://www.pbs.org/newshour/forum/january96/postman_1-17.html (June 25th, 2012)

concerns about the power visual-based forms of communication has over traditional (word-based) ones (Ellul, 1965). By doing so Ellul distances himself from the North American schools by further integrating social aspects and focusing on the image-over-word paradigm shift instead of the orality-over-writing division.

We shall conclude this short introduction to media ecology by acknowledging that this interdisciplinary field of study has been explored through the lenses of various theoretical backgrounds and is still evolving. A proof of its versatility is the various names media ecology is referred to, from the Toronto School to medium theory, American cultural studies, and mediology. The later, if interpreted according to Debray, illustrates well its focus on the interactions within specific systems instead of the actors themselves to study the effects culture and technical innovation have on each other (for instance in photography, how digitalization affected art photography). It thus promotes the study of technology and culture as one *with* the other and not *against* the other (Debray, 2000).

In the light of the aforementioned currents that defined media ecology over the past century as an approach to communication studies, and in particular the study of the new media's place in today's society, one can understand why the biological metaphor of ecology successfully describes the research field's interest. If ecology focuses on the interrelationships among living organisms and with their environment, media ecology thus refers to the study of the interplay between media producers, regulators and consumers in shaping the current nature of media.

Toward the new media ecosystem

In addition to *ecology*, another biological metaphor has been introduced by scholars to describe modern media: the *ecosystem*. A biological ecosystem is an environment composed of living organisms (animals, plants, etc.) interacting with the non-living organisms (soil, air, etc.) that characterize the environment. Similarly, today's media landscape can be seen as made of living organisms (network operators, content providers, etc.) interacting with non-living organisms (regulations, socio-historical dynamics, etc.) that define what media is today. The term ecosystem has been recently adopted by market analysts and telecommunication industry players to refer to the environment in which the mobile broadband standard Long Term Evolution (LTE) is being developed. Marshall McLuhan drew attention to this dimension of the ecological metaphor: the media only gain importance when related to other media. From this perspective, the media would be like species that coexist in the same ecosystem of communication. To conclude with the biological analogies, it is worth mentioning that the field of "ecosystem ecology" may be the best metaphorical illustration of the purpose of this introduction: To argue for the study of the media ecosystem from the interactions among its actors and with the ecosystem itself, rather than from the perspective of the content available to end-users alone, or the ongoing discussions regarding network regulation and distribution policies.

Following economist Alfred Marshall, Martin Fransman elaborated the ecosystem analogy to represent the new ICT economy, as illustrated in Figure 1.1. The four actors (or organisms) depicted in the diagram are either creators or users of knowledge, and can alternatively be organized in vertical layers, represented by the number above each actor. The analogy between ICT and biology is justified by the symbiotic nature of the relationships between these organisms, which are better described in terms of living forces in movement rather than in stationary mechanical states. In this scheme, new knowledge results from the interactions between creators and users of knowledge (Fransman, 2010).

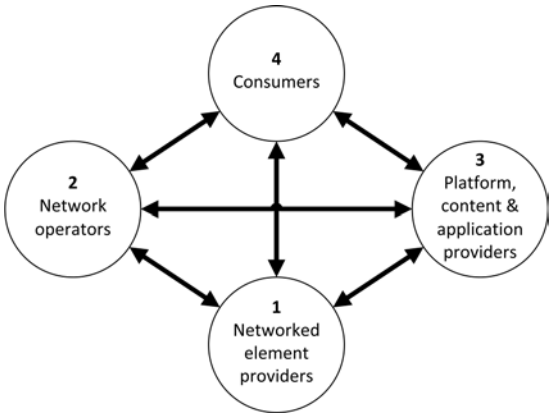


Figure 1.1: The four players and six symbiotic relationships in the new ICT ecosystem, according to Fransman (2010).

The structuring elements resulting in the current state of today's media ecosystem have been summarized in Corbella (2010). These seven elements are:

1. The opening up of Internet for public and private use
2. The improved cable networks by telecom operators
3. The digitalization of satellite TV
4. The elaboration of the first plan to implement Digital Terrestrial TV (DTT)
5. The adoption of DVD by the whole industry as digital support
6. The consolidation of videogames as alternative audiovisual activity
7. The birth of peer-to-peer activities to exchange audiovisual content

Corbella emphasizes the key role of Internet in leading the industry not only into creating more integrated businesses but also toward the development of converged media systems and organizations. The author also puts forward the development of media distribution into an *à la carte* model that deprives most media platforms from their potential negotiation with content providers. Instead, the poles of value in the new media value chains are

production and promotion. Corbella argues that the later is undergoing a transition from traditional promotional means such as premières in cinemas and programmes for generalist TV channels (which are still the most popular), to new ones such as virtual events on online social networks or programmes for non-linear audiovisual channels.

In a lecture on Political Economy of ICT[20], William Melody identified the driving forces and interactions at play in the new ICT environment as illustrated in Figure 1.2. It should be noted that end users were originally not included in the diagram. One of the reason for omitting explicit mention of end users is that their place on the diagram depends on the interest of the person who interprets it. Later in this study, end users will be considered as mobile media services consumers hence interacting primarily with the technological applications (illustrated by continuous arrows on the diagram), while being indirectly influenced by economic and regulative forces (dotted arrows).

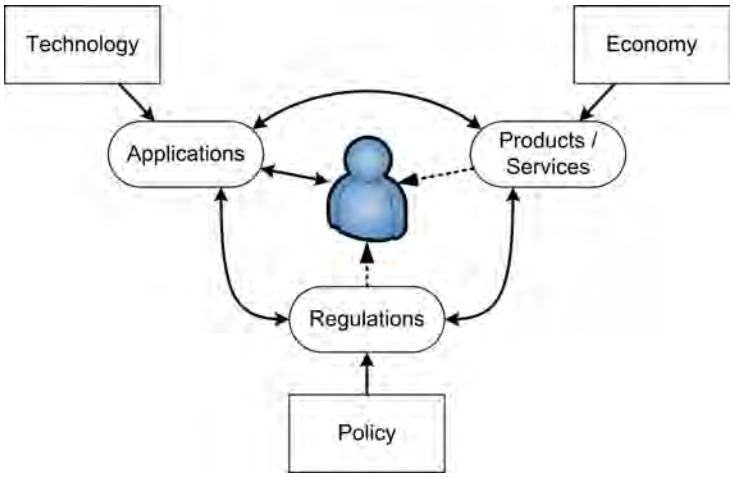


Figure 1.2: The driving forces and their interaction, adapted from lecture by Melody.

Additionally, Melody introduced the notion of knowledge economy (in contrast with its predecessor the industrial economy) to describe the type of economy that relies on the interdependence between information and communication. Complementing Corbella's list, Melody considers the following features as part of knowledge economies (Melody, 2007), all of which calling for great attention from policy makers.

Information infrastructure The development of broadband networks facilitates next generation knowledge economy activities.

Information content Policies concerning patents and Intellectual Property Rights (IPR) evolve alongside the development of the knowledge economy.

[20]Lecture given at the 2009 summer school on Political Economy of Information and Communication Technologies, with special focus on Next Generation Mobile Media (Organized by the Center for Communication, Media and Information Technologies, Aalborg University).

Human capital Humans are recognized as principal producers, repositories, disseminators and appliers of information and knowledge.

Applications for increased productivity Increasing productivity requires improving capability, reducing transaction costs and stimulating structural changes within organizations, industries and markets.

Structure and efficiency Restructuring current oligopolies may hinder the activities of the knowledge economy.

International trade All previous considerations shall be understood in an international scale and thus impact the global knowledge economy.

Illustrating the difficulties encountered by the new media ecosystem, Corbella lists the following issues to have been passed on to the new system from its predecessor:

- The instability of the system's financing, based mostly on advertisement revenues and partly due to the reluctance of consumers to pay for services that are also accessible free of charge by other means
- The widespread practice of accessing illegal copies of multimedia content
- The issue of granting rare TV and radio licenses which, if it has been rendered strategically unimportant, causes difficulties in regulating the actions of corporate players
- The regulations concerning content circulation
- The protection of content exploitation over time

The two last items are examples of issues typical of an earlier media environment that call for revision and adaptation to the new conditions under which media is produced, distributed and consumed. Additionally Corbella mentions new issues that arise from the advent of the new media ecosystem, namely the need for higher transmission capacity over broadband distribution networks and the need to regulate the role of telecom operators in delivering content to end users.

End users, however, are only partially concerned by these issues. Examples of more direct transitional problems affecting end users are the renewal of equipment required to access media content in its new formats, the acceptance of new billing models, or the troublesomeness of finding appropriate content in the sea of offers available.

All actors of the mobile TV value chain, from mobile device manufacturers to network providers and payment agents as defined in Trefzger (2005), contribute to the end user experience either by supplying a handheld platform supporting the technologies concerned, a broadcasting format or some content to be consumed. Therefore a regain of interest in potential mobile TV enabling technologies calls for continuing user research in the field. Indeed numerous empirical studies conducted by industrial and educational institutions illustrate the strong impact of usability on the degree of service acceptance by end users. For instance, the extensive bibliography used in Coursaris

& Kim (2006) provides a valuable source of information regarding methodologies and setups used to evaluate various aspects of mobile usability. These cover issues from design guidelines for handheld applications (Chan et al., 2002) to comparison between laboratory and field testing of mobile applications (Kaikkonen et al., 2005).

We have now established a comprehensive picture of new media as a complex ecosystem, and introduced classic theories to study the interactions between its elements. Based on this grounding material, the remaining of the thesis will focus firstly on the converging dynamics observable within the ecosystem, and secondly on the interaction between end-users and applications of new media. In particular we will explore the increasing combination of television and mobile technology through a number of user studies, the results of which are presented and discussed in Part I. This will allow us to answer the research question I and its related sub-questions. Then, Part II will investigate the practical mechanisms behind those user studies, in order to answer research question II and the related sub-questions.

Final draft

Part I

Convergence

"Mobile digital convergence is leading to the situation where one customer buys our product for its video properties, another to listen to music, others to take pictures or access e-mails on the move."

Anssi Vanjoki

This first part addresses issues related to convergence, this complex concept being defined in the following paragraphs. Based on this definition, a number of questions arise. For instance, one might note that not all new media dynamics are converging, and that instead some aspects show diverging tendencies. One might also question if these trends are general or culture specific, and how end users in various regions make sense of the changes in their relation to media brought out by this evolutionary process. Chapter 2 will investigate these issues by exploring convergence from the viewpoints of technology, culture, broadcasters, and end users. Then, Chapter 3 will look specifically at the coming together of television and mobile technologies, through the lenses of various user studies. Finally, Chapter 4 summarizes our findings. Prior to examining those issues, the following paragraphs defines how we understand the concept of convergence.

What we talk about when we talk about convergence

Convergence is an ambiguous and hard-to-define concept because it can refer to many different ideas and processes. "*It is used differently, both with regard to what is converging (networks, terminals, social practices, etc), and with what happens when something converges (merging, new complexities, etc)*" (Storsul & Stuedahl, 2007, p. 13). In order to better frame the upcoming chapters and make sense of the sprawling definition of convergence, this section reviews how this key concept has been defined by new media authors.

In academic and industrial publications, authors have used the term to describe any phenomena related to the development of digital media. Acknowledging that convergence occurs across media organizations (institutional convergence), across consumers (cultural convergence), and across platforms (technological convergence), in a carefully regulated environment (regulatory convergence), this thesis will later focus on how end users perceive the evolutions that occur at the platform level. However, in order to understand the mechanisms of convergence from a holistic point of view, it is critical to be aware of the four perspectives and their potential interrelations. The following will therefore provide an overview of these complementary and interdependent perspectives.

Studying the blurring of mass and interpersonal communication, Lüders argues that converging forms of communication rely on three processes: *interaction*, *participation*, and *social integration* (Lüders, 2007). On the one hand, interaction offers symmetrical communication channels, which typically contrasts with the asymmetrical communication process of mass media (to which new media is opposed). The bi-directional dialogue resulting from interactions should however not be over acclaimed or promoted as superior to mass media's monologue, which is expected to keep a significant role in future media consumption. On the other hand, audience participation in new media differs from that of mass media as it is unformatted and unedited. Despite the issues raised by the integration of unedited material into their in-house created content, user generated content has become vital to media corporations who encourage audiences to voice their opinion and share stories and

multimedia creations. Finally, social integration refers to the ritual functions of mediated communication, which Lüders considers reflecting a desire to situate oneself in relation to others. Overall, Lüders argues that if "*the opposite ends of the interpersonal and mass-mediated communication axis are still easily distinguishable*" (Lüders, 2007, p. 195) (for instance phone calls versus newspapers), an increasing grey area exists within which the boundaries between mass and interpersonal communication have become somehow irrelevant.

According to Henri Jenkins (named "the 21th century McLuhan" by Howard Rheingold reviewing *Convergence Culture*), convergence is more than the tendency of various types of media to be available for consumption on a single device thanks to technological evolution. Instead, convergence occurs on five levels: technological, economic, social, cultural, and global (Jenkins, 2001). He argues against the early vision of convergence, describing the phenomenon as the advent of an "übercomputer", a singular device managing all accesses to media: "*No single medium is going to win the battle for our ears and eyeballs. And when will we get all of our media funnelled to us through one box? Never.*" (Jenkins, 2001, p. 93). More than a technological process, convergence is mostly a cultural shift as audiences reach out for new information and build bridges between dispersed content. For the new media industry to succeed at offering desirable content to users over the numerous receiving devices available, media production, regulation and consumption should all encompass converging strategies. Nevertheless, when considering mobile media consumption from an end user perspective, convergence relies heavily on the consumer device(s). The recent development and widespread adoption of smartphones can be seen as representative of the tendency for consumers to use fewer devices to engage in communication and media related activities at home and when on the move.

Numerous authors are in agreement with Jenkins's perspective on convergence. According to Pavlik & McIntosh, convergence is "*the coming together of computing, telecommunications, and media in a digital environment*" (Pavlik & McIntosh, 2010, p. 8) and happens at three overlapping levels: technological, economical and cultural.

> "*Technological convergence refers to specific types of media, such as print, audio, and video, all converging into a digital media form.*"
>
> (Pavlik & McIntosh, 2010, p. 8)

The resulting digital media transforms not only the nature of the original media but also the way it is generated and distributed. Considering a newspaper as an example, today's journalists often produce content using various audiovisual technologies, and readers increasingly access the content on portable media devices (such as the Amazon Kindle and tablets), which extend the basic functionality of simply reading an article to sharing it through social networks and searching the Internet for further information.

> "*Economic convergence refers to the merging of Internet or telecommunication companies with traditional media companies.*"
>
> (Pavlik & McIntosh, 2010, p. 9)

The outcome of this convergence is new corporations that control not only the content but also the distribution of media. A potential censorship issue however arises from such organization. If in appearance the audience has access to a broader selection of content (visible for instance in the number of television channels available now compared to the early 1990s), choice might in fact be dictated by conflicts of interest inside the media giants and distribution strategies focusing on the most profitable types of content.

> *"One aspect of cultural convergence comes from the process of globalization of media content [, but] we can also look at cultural convergence from the perspective of how we consume, create, and distribute media content."*
>
> (Pavlik & McIntosh, 2010, pp. 10-11)

Concerning media globalization, this process helps content owners reach a broader audience. The latter perspective mostly concerns the fading border between mass and interpersonal communications. With an increasing ability to produce their own content and distribute it through online social platforms, audiences now play an important role in producing multimedia content that complements that of traditional media companies. Finally, by using the same distribution channels as their audience, media giants can increasingly adapt their communication strategies to better deliver their content to individuals.

In conclusion to this definition, we shall consider the relevance of the following six dimensions of convergence in explaining recent developments in the media landscape, as proposed in Fagerjord & Storsul (2007). Noticeable in the list below is the intertwined relationship between convergence and diversification.

Network convergence Digitazation enables the distribution of any kind of data (sound, text, image) and allows triple-play offers (television + telephony + IP access) to consumers[21].

Terminal convergence Despite terminals being capable of fulfilling more functions, the diversity of terminals being constructed constantly increases.

Service convergence New cross-platform multimedia services have emerged taking advantage of network and terminal convergence.

Rhetorical convergence Typical genres of various media may be mixed and new genres may emerge borrowing from various media traditions.

Market convergence Several markets are now interacting, within which corporations espouse vertical integration or narrow specialization.

Regulatory convergence If networks have generally adopted common regulations, media and services are regulated independently.

[21] Today in 2012, quadruple-play offers (TV, IP, fixed and mobile telephony) become popular among European telecom operators, as further discussed in Section 2.1.

Final draft

CHAPTER 2

THE ECOLOGY OF MEDIA CONVERGENCE

This chapter defines what can be called a *converging media ecosystem*. It introduces theories from researchers and practitioners active in various fields to illustrate the intertwined relationships between technology, service and content providers, policy makers and end users in shaping new media. This chapter thus works toward answering the first sub-research question I.a as formulated in Introduction: *How the technological and cultural aspects of media convergence affect broadcasters' content distribution strategies and end users' consumption practices?* Even though the thesis will later primarily focus on the end user perspective, it is important to be aware of and acknowledge the role of all stakeholders in this field of study. This acknowledgement opens the perspective on topics otherwise restricted by self-imposed boundaries, or research methodology traditions. As a simplified example, in order to fully understand the effects of user-generated content on national media production, it is not only necessary to scrutinize the reshaping of national broadcasting firms and their media creation process; it is also critical to recognize the role played by technology providers in encouraging hobbyist creating semi-professional content and distributing it to the masses via novel distribution channels. The data reported in this chapter comes from conducting literature and market reviews, expert interviews (both in Denmark and Japan), and an online survey (also in the two countries). At the time of writing this data is only available in this dissertation.

2.1 Technology

The first level at which convergence can be studied is from the viewpoint of the technology that facilitates it. A few obvious examples of convergence happening at the device level include: game consoles with Internet access, television sets with memory card readers, mobile phones with GPS-based navigation. This section first justifies the importance to consider this phe-

nomenon from the perspective of broadcasters, before introducing commercially available examples of converging technology.

From an economic perspective, the attitude of a country with regard to technology has been recently included in the measurement framework of its growth and regional convergence (Bernard & Jones, 1996). This raises issues related to how to measure technological advancement in a comparable way across countries or regions. However, including technology as part of the measurement framework has proven to increase economic convergence rates (Islam, 2003), notably in Europe (Žižmond & Novak, 2007, Alexiadis, 2011). The issues related to economic convergence due to technology adoption illustrates a perspective of convergence not investigated in this dissertation. However acknowledging this macro-economic phenomena broadens the perspective of the present work and opens up for new research directions based on the findings presented in this thesis.

From a media point of view, broadcasters' intention of supporting multiple platforms and devices makes good sense as ubiquitous computing is becoming increasingly widespread and popular. As media technologies develop, new cross-platform media practices emerge at home and at the workplace which necessitate even further technological integration. As a example, a two-month study of 11 mobile information workers in a large Finish IT company showed that work-related tasks on a daily basis are heavily distributed among a wide selection of devices (including desktop PCs, laptops and various handhelds) (Oulasvirta & Sumari, 2007). Similarly, Dearman & Pierce interviewed 27 workers from academia and the industry and found that ubiquitous computing is present not only at work but also in private homes (Dearman & Pierce, 2008). In average, the participants had one laptop/desktop PC at work/school and one at home, and carried one cellular device and at least one portable media device such as digital camera or iPod. Most participants even had a dedicated laptop PC for bringing between work/school and home on a regular basis. In addition to switching between devices for different tasks, the participants were found to increasingly engage in activities that span devices (e.g. using a laptop PC in combination with a desktop PC). Participants in both studies reported that synchronizing information across the devices constitutes a challenge. In order to cope with this, they use a combination of portable media, emailing, shared directories and server-based services.

As a popular example of technology convergence, the merging of PC and TV seems unavoidable. This tendency has been observed and investigated since the 1990s by media authors, among which computer scientist and Wired's columnist Nicholas Negroponte. In 1995 his position on the matter was the transformation of television into a PC-like entertainment platform, rather than the other way around. Negroponte strongly advocated that the consumer and computer-user markets respectively addressed by television and PC manufacturers are one and only market (Negroponte, 1995b). The author reflected on the technological similarities between the two types of terminal, calling them both "bit processors". Moreover in *Being Digital*, Negroponte developed the analogy of "bits and atoms" (standing for digital

information and tangible media such as laptops, CDs and videocassettes) to reflect on the transformation of traditional media technology "*digitally driven by the combined forces of convenience, economic imperative, and deregulation*" (Negroponte, 1995a, p. 13).

Lately however, the distinction between PC and television and the direction of their convergence has become increasingly blurred, as summarized by Pavlik & McIntosh.

> "*It is still too early to predict whether the television will absorb the functions of the PC or the PC will adopt more TV-like functions, but either way, what we know today as two separate items (essentially two separate monitors) will merge into one, and in the end it will not matter.*"
>
> (Pavlik & McIntosh, 2010, p. 89)

On the one hand, the recent development of 'smart' TVs, the emergence of highly interactive TV programmes which triggers audience participation, and the increased physical activity involved in video games to be displayed on TV sets, tend to indicate that from a manufacturer and content provider points of view, the originally lean-back TV is slowly moving towards the more active computer. On the other hand, recent computers integrate TV tuners and software suites dedicated to watch and record live shows, and to navigate through programme guides, while in parallel computer screens are commonly becoming bigger. As a result, these home PCs can be used as TV receivers and in fact, replace TV sets in a growing number of homes. The direction of the tendency described by Pavlik & McIntosh is indeed hard to predict, and will most likely depend on a mixture of factors based on technology push by manufacturers, evolution of show formats by content providers, and eventually by user adoption.

As discussed in Han et al. (2009) and schematized in Figure 2.1, the joint evolution of dedicated and converged technology devices leads to an overlapping performance level at which both types of devices are comparable (illustrated by the blue gradient area in the figure). For instance, today's smartphones sporting 8+ megapixel cameras arguably match some dedicated cameras. For consumers, the interest of buying such camera rapidly decreases, and at equal performances, people now tend to opt for the converged form factor rather than for the dedicated one (Han et al., 2009).

Fixed-mobile convergence

Especially relevant to this thesis is the development of fixed-mobile convergence, which according to the Fixed-Mobile Convergence Alliance (FMCA)[1], "*aims to accelerate the development and adoption of convergence technologies by*

[1] The FMCA stopped its activities in 2010.

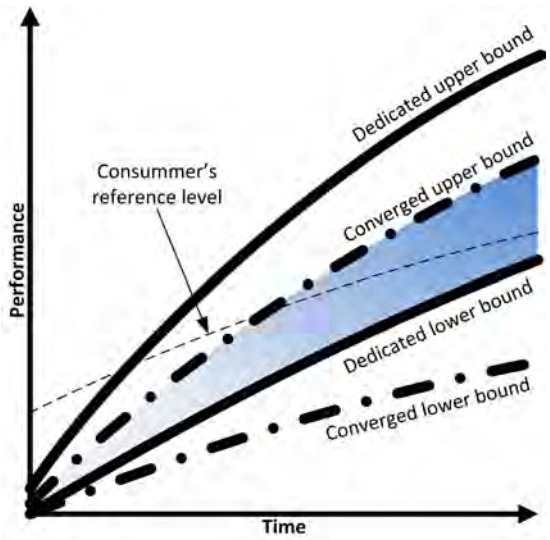


Figure 2.1: *Dedicated and converged technology trajectories.* Adapted from Han et al. (2009).

producing common telecommunication requirements for converged cellular/Wi-Fi/WiMAX products and services" (Okamoto, 2007, p. 10). Fixed-mobile convergence (FMC) results from the declining average revenues per user (ARPUs) first in the fixed and more recently in the mobile markets. FMC was confronted at first by a lack of standardization, an issue that has been recently tackled, for instance by the International Telecommunication Union (ITU) through various recommendations (see for instance ITU (2009a,b)).

For end users, this process is clearly visible from the cheer number of functions supported by today's smartphones, compared to that of a few years ago. The only affordance of the technology in its early days, placing a call, is no longer the reason for adopting such device. In particular, the possibility to synchronize mobile and fixed computing devices has become a primary concern for adoption of mobile technology, as pointed out in Oulasvirta & Sumari and Dearman & Pierce's studies. Similarly, when analysing online reviews of various mobile devices, compatibility with other devices emerged as a significant indicator of performance for consumers (Gebauer et al., 2008). One may thus ask if the converging point of media technology is the mobile phone. As introduced in the next paragraphs, this seems to be already the case in Japan.

During my stay at the University of Tokyo, I had the opportunity to interview Sumaru Niida, project Manager at KDDI R&D Laboratories, who introduced me to KDDI's perspective on Fixed Mobile and Broadcasting Convergence (Niida, 2011). In essence the idea is to offer end users seamless integration of the home mobile network, J:Com's cable TV services[2], and

[2]J:Com is a leading broadcasting and communication organization that delivers 17 specialized channels to five major Japanese metropolitan areas as part of their integrated cable of-

fixed telephony, together with KDDI's mobile offer. With that purpose in mind, new converging technology for cellular phones and TV programmes is under development. According to Niida-san, a substantial part of this research is invested in further developing solutions for providing TV services on mobile phones. Keitais indeed increasingly act as an identification token to access information. In that regard, this aspect of technology convergence clearly leans toward the mobile phone as the centrepiece of the personal media ecosystem. As a first step into this direction, KDDI focuses primarily on developing simple and reliable services, expecting that market adoption will drive future sophistication of the technology. User research in this area is today based on ethnographic research, and Niida-san is highly involved in this research. For instance, tolerance to waiting time on mobile phone is currently his main focus area (Niida et al., 2010, 2011), although he is also involved in conducting in-depth ethnographic studies of high-speed access points with laptops at home, as well as engaging engineers and general citizens in collaborative discussions. As far as this type of research is visible from outside Japanese telecommunication companies, KDDI is leading the field in integrating user research into the technology development process.

As Niida-san also noted, the imbalance of the Japanese personal media ecosystem toward mobile devices is also explained from cost and cultural perspectives. Japanese users with lower salaries tend to use (and own) only a mobile phone, while wealthier users also use personal computers at home. The mobile phone thus appears as the default ICT equipment. Mobile phones are perceived easier to use for short usage duration as they are always on. In addition, popular social networks such as Mixi or Twitter are highly suitable for mobile phones and are also regarded as easier to use on such platform than computers. Additionally, the keitai, concept roughly translated as mobile phones, refers to something that one carries around everywhere, including inside homes. The omnipresence of mobile phones is thus an explanatory factor of media convergence happening around this device in Japan.

As a result of the development of FMC technology, quadruple play solutions, which include television, Internet access, fixed and mobile telephony, are becoming common options for consumers looking for all-in-one media access packages. The European quad-play market increases rapidly, an example of which is seen in France, where a high level of competition between Internet access providers has led to very attractive offers, of which some basic characteristics are summarized in Table 2.1. One of the main benefits of such offers is the convenience it provides end users who can access information and communicate regardless of the platform they use, as expressed by Basilier et al..

> *"User convenience is fundamental to drive the mass market of broadband services, especially as the variety of devices and services grow. User convenience encompasses security, simplicity, personalization, and look and feel. It is about always being able to communicate*

fer, which includes television, high-speed Internet, and fixed telephony: http://www.jcom.co.jp/corporate_en/business.html (June 7th, 2012).

> *and reach services in a consistent and intuitive way, independent of which access is used."*
>
> (Basilier et al., 2007, p. 2)

Table 2.1: Quadruple play offers in France (June 2012).

	numericable	free	Bouygues Telecom	SFR	orange
Monthly price	44.89€	53.96€	62.80€*	61.90€	74.90€
Internet speed	30 Mbps	25 Mbps	20 Mbps	20 Mbps	20 Mbps
TV channels	19	200	150	150	150
Mobile offer	Unlimited national calls and SMS to fixed and mobiles				

* The first year, then 72.80€

Worldwide, the technology that supports media convergence is currently undergoing great modifications. At the same time cultural perspectives on media consumption evolve and bring about new practices. The cultural forces at play in this evolution are the focus point of the next section.

2.2 Culture

Beside the technology and media institution perspectives, cultural convergence plays a major role in defining the new media ecosystem. In a digital society, lives are "liquid" and lived "in" media (Deuze, 2007). All aspects of people's lives are interconnected and overlap each other through media. In order to understand what convergence means from a cultural stance, we shall start by examining Jenkins's idea of convergence, as thoroughly established in his introduction to *Convergence Culture: Where Old and New Media Collide*:

> *"By convergence, I mean the flow of content across multiple media platforms, the cooperation between multiple media industries, and the migratory behavior of media audiences who will go almost anywhere in search of the kinds of entertainment experience they want. Convergence is a word that manages to describe technological, industrial, cultural, and social changes depending on who's speaking and what they think they are talking about. [pp. 2-3]*
> *I will argue here against the idea that convergence should be understood primarily as a technological process bringing together multiple media functions within the same devices. Instead, convergence represents a cultural shift as consumers are encouraged to seek out new information and make connections among disperse media content. [...] Convergence does not occur through media appliances, however sophisticated they may become. Convergence occurs within the brains of individual consumers and through their social interactions with others. [p. 3]*
> *Delivery technologies become obsolete and get replaced; media, on the other hand, evolve. [p. 13]*
> *[Citing Lyons-Cavazos et al. (2002)], "The old idea of convergence was that all devices would converge into one central device that did everything for you (à la universal remote). What we are now seeing is the hardware diverging while the content converges." [p. 15]*
> *Convergence alters the logic by which media industries operate and by which media consumers process news, and entertainment. Keep this in mind: convergence refers to a process, not an endpoint. [pp. 15-16]*
> *Convergence involves both a change in the way media is produced and a change in the way media is consumed. [p. 16]"*
>
> (Jenkins, 2006b)

While acknowledging "*how central mobiles have become to the process of media convergence*" (Jenkins, 2006b, p. 5), the above definition clearly emphasizes the cultural aspect of media convergence over the accumulation of functions into today's mobile devices. Moreover, *Convergence culture* argues that media consumption has become a collective process, what Pierre Lévy called "collective intelligence"[3]. To exemplify the outcome of this process, Jenkins explores

[3] Pierre Lévy on Collective Intelligence Literacy, interview by Howard Rheingold: http://www.youtube.com/watch?v=8kCV4EEy2lE (April 21st, 2012).

the world of *The Matrix* as transmedia storytelling. The franchise indeed spread across a multitude of media including the three films, an animation series, two video games, and numerous web sites and online forums. The idea behind its success was to offer audiences multiple asynchronous entry points to the story, while disseminating subplots and hidden messages throughout the intrigue. This triggered the audience interest and desire to search for more about the story, which resulted in countless discussions and generation of fan made material that participated in further enhancing an already extremely rich universe.

Convergence or divergence?

The diversification and blurring of delivery platforms put forward by Jenkins' description of transmedia storytelling can be argued to illustrate divergence or fragmentation rather than convergence. A first argument for a more diverging depiction of new media is the apparition of ever more technological apparatuses, putting consumers in front of a virtually infinite range of possibilities when acquiring new media equipment. In turn this diversity in supporting technology generates an equally vast range of options concerning how to access and create media. At the same time, one might argue that those devices integrate a limited (and rather short) list of functions, the packaging being the only differential element of the object. Nevertheless, taking the case of mobile phones, however similar in functions, different devices are perceived differently by consumers. This difference in perception is socially constructed (Campbell & Russo, 2003) and heavily influenced by the physical design of the device (Chuang et al., 2001, Suteja & Tedjohartoko, 2011).

From a content production perspective, the accessibility of tools and the professionalism claimed by audiences generating content gives birth to another converging yet diverging dimension of the media landscape, between the highly cinematic look of television productions, and the intimacy of online personal productions. Taking the example of online drama, Creeber argues for "the return of the intimate screen", which blends traditional and modern media broadcasting practices (Creeber, 2011). The spreading of participatory culture and the breaking of barriers between consumers and producers create great changes in the media production industry, a process thoroughly investigated by John Caldwell in *Production culture* (Caldwell, 2008). Media producers need to acknowledge and leverage the power of online media alternatives to traditional distribution channels such as YouTube or Last.fm in their content distribution strategy. For instance in the case of YouTube, more than a platform for broadcasting home-made videos generated by non-professionals, YouTube acts in fact as a social filter, putting forward the material that people find interesting, disregarding its level of professionalism. In fact, despite the large number of home-made videos available on the platform, the most viewed ones are actually the professionally edited ones (Kruitbosch & Nack, 2008). At the same time, YouTube and television are getting more similar in terms of flow, liveness, broadcasting, form, and content (Vermeer, 2011). Even though the following work in this thesis will not focus specifically on YouTube, it is crucial to recognise its role in bringing professional

content owners and producers together with end users, an increasing number of whom are becoming "produsers" (Bruns, 2007). As a final comment on YouTube, some consider the platform as the future evolutionary step of television (see for instance Uricchio (2009)), a vision that makes sense in the light of the increasing presence of YouTube applications on today's smart TVs.

In the introduction to *Convergence and Fragmentation: Media Technology and the Information Society*, Peter Ludes focuses on the European Information Knowledge Society and identifies both converging and diverging trends allowing "unity in diversity" (Ludes, 2008). According to him, achieving European media unity requires better understanding of culture-specific media and more transcultural initiatives to offer access to a common pool of knowledge. Elaborating on this idea, Heller (2008) reviews the trends in the global and European ICT development. Heller contrasts converging trends in ICT development (increased availability of similar devices and the possibility to access the same content on various media) to the risk of creating a greater digital divide as well as increased public fragmentation. As a result of these observations, she asks: "*Do users/citizens/individuals become more dominated and passive by the entertaining functions of the new devices or do they become more active and partaking in growing democratic participatory discussions?*" (Heller, 2008, p. 30) The many recent accounts of new media use as a mean of organizing citizens and expressing public opinion tend to support the latter development.

Elaborating on the idea of collective intelligence in *We Think: mass innovation, not mass production*, Charles Leadbeater explores cultural convergence through the lens of participatory culture, illustrated by the success of Wikipedia. In Leadbeater's words, *We Think* is "*a different way of approaching how we organise ourselves, one that offers significant opportunities to improve how we work, consume and innovate*" (Leadbeater, 2009, p. 24). This process thus goes beyond mere participation, and challenges audiences to redefine collaboration on a global scale. However Leadbeater reckons that a set of conditions needs to be fulfilled to ensure *We Think*'s success.

> "*Usually, a small group creates a kernel that invites further contributions. Their project must be regarded as exciting, intriguing and challenging by enough people with the time, means and motivation to contribute. Tools should be distributed, experimentation cheap and feedback fast, enabling a constant process of trialling, testing and refinement. The product should benefit from extensive peer review, to correct errors and verify good ideas. Tasks should be broken down into modules around which small, close-knit teams can form allowing a range of experiments to run in parallel. There should be clear rules for fitting the modules together and separating good ideas from bad. Ownership of the project must have a public component, otherwise the sharing of ideas will not make sense.*"
>
> (Leadbeater, 2009, pp. 84-86)

Looking specifically at the Scandinavian media landscape, Lund notes the common attributes shared by the Danish, Swedish and Norwegian media ecosystems. For instance the development of traditional mass media (press, radio and television) adopting a democratic-corporate model that differs greatly from that of Southern European states and to an even greater extend to the United States'. In this model, "*the mass media are assigned a political role as proxy citizens, representing a diversity of voices and connecting the masses with competing elites*" (Lund, 2007, p. 123). Mass media is thus supposed to avoid concentration of power and engage citizens in the democratic process. It also encourages news consumption, especially concerning public affairs and international issues (Curran et al., 2009). This perspective reminds of Castells's concept of mass self-communication, according to which the horizontal network of communication supported by online media brings about the possibility to participate in political discussions: "*The media are not the holders of power, but they constitute by and large the space where power is decided.*" (Castells, 2007, p. 242) In practical terms however, the voices expressed on this network have good chances to remain unheard or ignored.

Finally, in order to appreciate the central role of mobile phones in convergence cultures, one may look at Japan and the "mobile-izing" process (Miyata et al., 2004, 2005) it has being experiencing since the late 1990s. Not specific to Japan however, mobile users who use multiple media "*tend to have stronger and more frequently contacted ties*" (Miyata et al., 2004, p. 159). At the time Miyata et al.'s study was conducted (late 2002), mobile phones in Japan were primarily used to reinforce social ties within close physical proximity, rather than to maintain weak social connections, to develop one's network further, to reach for information, or to participate in online discussions. This supports the assumption that modern societies are embracing 'networked individualism' in which the individual is the unit of connectivity, rather than 'neighbourhood and kinship solidarities' (in which a group such as a household is the unit). The evolution of information societies from 'little boxes' to 'glocalized' networks and eventually to 'networked individualism' as observed in Wellman (2002) and Wellman et al. (2003) is partly due to the shift between *place-to-place* to *person-to-person* connections, illustrated by the shift between fixed to mobile telephony. It has been for instance argued that ICT "*has the potential for transforming societies into networked communities or community networks*" (Hofkirchner, 2009, p. 71). As a result of this process, Wellman wonders if individuals take responsibility for only strong existing relationships and not for weaker ties; and whether new social needs emerge from the reshaping of digital lives. For instance in the Japanese context of youth relationship to regulation and surveillance, Ito observed the role of the mobile culture in creating and structuring "new disciplines and institutional relations". More generally though, the mobile phone is a socio-technical device reflecting the cultural context within which it is used (Ito, 2005). It should also be noted that the notion of networked individualism has been recently criticized for its somehow pessimistic vision of how new media transform societies.

The relative confusion in the previous summary of the various cultural dimensions of convergence does not come as a surprise. In fact, Jenkins warned us already in 2006, as reminded below.

> *"For the foreseeable future, convergence will be a kind of kludge–a jerry-rigged relationship among different media technologies–rather than a fully integrated system."*
>
> (Jenkins, 2006b, p 17)

Keeping in mind that "*the tools available to a culture matter, but what that culture chooses to do with those tools matters more*" (Jenkins, 2009, p. 8), and that today's digital cultures rely on participation, remediation and bricolage (Deuze, 2006), the next section will therefore address how broadcasters make sense of this bricolage, and how they adapt their content delivery strategies to the new multi-platform environment they are now dealing with, and the new practices sought for by their audience.

2.3 Broadcasters

TV broadcasters are no longer only focusing on traditional TV sets when broadcasting content. Large broadcasters such as the British Broadcasting Corporation (BBC), Zweites Deutches Fernsehen (ZDF) and Danmarks Radio (DR) explicitly guarantee that British, German and Danish audiences can get free access to services in ways and on devices that suit them, acknowledging that users want potential access to media at all times. In addition, users can catch up on programmes for free using online services either at home, or on the move (Berthold et al., 2010, Thompson, 2010). BBC, ZDF and DR have all launched media portals to facilitate this, namely the BBC iPlayer (Kozamernik, 2008), the ZDF Mediathek (Berthold et al., 2010) and DR Nu. The platforms enable users to watch live television as well as catch up with TV programmes from the past week, which can be done from Internet-connected computers, set-top boxes, media centres and mobile phones. These services appear to be quite popular among end users: already in 2008 the BBC iPlayer streamed approximately 100 TBs of data per day, and it received 120.000.000 requests in January 2010. Similarly the ZDF Mediathek reported around 15.000.000 viewings per month in 2010. Finally, the success of DR Nu is still hard to measure, as the service was released in 2011.

Current and future trends in Denmark

This section is partially based on interviews with Jacob Wieland, audience researcher at the Danish Broadcasting Corporation (Danmarks Radio, DR) and Johan Winbladh, digital media project manager at TV 2, the first Danish private broadcasting corporation. (Wieland, 2012, Winbladh, 2012)

Jacob Wieland, audience researcher at DR

During my interview with him, Jacob Wieland described the current status and possible future development of converged media from DR's perspective, focusing primarily on the reception of second screen applications among the Danish TV audience. Describing the current development state of services combining TV and mobile technologies, Wieland argues that "*we know nothing about the whole concept of second screen; we are at the beginning of something*". Additionally, referring to Thunø (2011) in fact "*people are using Internet while watching TV and that will prove to be a huge challenge for broadcasters*", especially that what remains unknown is the time and frequency of such activity, as well as the type of content people are actually browsing for. Confirming the tendency of media multitasking, Thunø (2011) reports insights on media usage in Denmark, and particularly related to the field of media convergence. For instance it indicates that 56% of Danes browse Internet on smartphones from their couch, and 49% report explicitly using Internet while watching TV (73% of whom do it daily). Further validating the importance of Internet use in front of TV, 45% of those using Internet while watching TV claim focusing mostly on using Internet when doing so, against 19% focusing on the TV set, and 32% on both devices at the same time. In

order to develop engaging second screen services related to their TV shows, one of the challenges for broadcasting corporations is thus to understand the added value of such interactive applications, as critical mass adoption could only be reached if viewers can clearly see what's in it for them.

Various types of TV shows might be more suitable for interaction than others, and Wieland explains how news could be an exciting platform to experiment with. Indeed, many TV news viewers claim their intention to read on some of the topics presented after the broadcast ends; however as reported in (Schaap et al., 2009, p. 33) a number of studies have demonstrated that in average people recall only one or two stories presented in a typical newscast, and in fact people rarely further investigate news stories after the bulletin is over. In this typical situation, a second screen service would support digging for more relevant information and bookmarking topics for later review. Additionally, this contextualization of the news stories would help alleviating the recurrent issue journalists face concerning how much background information to provide when reporting stories. Wieland refers to the news bulletin audience not as *viewers* but as *news consumers*, who access news several times a day on different devices (radio, mobile devices, TV) according to the context they are in. "*At the end of the day, you don't need to tell people what's happening. They already know*". The different devices might therefore fulfil different functions, such as continuous investigation (hour by hour) on radio, and story summary on TV.

Similarly, the interaction between a TV show and its audience as well as the interaction among the audience relies on the medium used to interact. For instance Wieland notes that discussions about specific TV shows taking place on platforms such as Facebook where real names are visible are more constructive than when debaters use pseudonyms. Broadcasters therefore should leverage the power of such online discussion platforms to engage their audience in valuable debates.

The interview also addressed the possible need to rethink the traditional Danish flow TV, as defined by Hojbjerg (2001). Nowadays in Denmark flow TV represents 98% of all viewing, leaving only 1% to on-demand and 1% to time-shifted viewing. As transferring content across devices becomes integrated into TV watching habits, second screen services could transform the traditional flow TV into a more personalized flow. Flow TV however makes it easy for viewers to decide on the content and this seems to make a compelling argument for its popularity now and possibly in the future as well. This typical situation is illustrated in the following vivid description by Wieland of a young couple arguing about what TV content to watch together:

> "*Every time we discuss which movie to watch it takes forever. I wanna see something with Bruce Willis who kicks asses, and she wants to see a Japanese movie about a young couple living in the suburbs of Tokyo. So there we are... but when you turn on the television, it makes the choice for you. We can be watching the lousiest movie and sit here laughing about it "we wasted 2 hours on this shit..." but*

> *we did it. We could take Emmy winners, Golden Globes winners and watch them but we don't.*"
>
> (Wieland, 2012)

The above scene reflects the social aspect of TV, which is not only about the content but also (and mostly) about spending time together. This social aspect of TV has been extensively discussed in recent scientific literature (see for instance the work by Geerts & De Grooff (2009), Cesar & Geerts (2011a,b)). Similarly, Wieland elaborates specifically on family settings and notes that TV is a social practice based on compromises. Particularly, the choice of TV content to be watched by the family is commonly decided on by children. TV watching is also guided by cultural practices: "*you know your neighbours and colleagues are watching what you're watching too*", indicating the importance of belonging to a community characterized by a specific media consumption behaviour.

Another theme covered in the interview is the current disinterest in mobile TV as it was discussed around 2003-2006. Nowadays broadcasters will ensure that their content is available on a variety of platforms, but not necessarily focus on producing platform-specific content. Referring back to McLuhan's "the medium is the message", Wieland argues that "*even though the content is the same, people use it differently depending on the media. Every time you publish your content on a different media, a new experience is created, and we [broadcasters] need to learn about these kinds of experiences*". A potential candidate device for watching TV outside the living room is the tablet. Its bigger screen makes it more suitable for niche TV watching practices, such as during holidays, or in other rooms at home. Such practices, together with TV experiences tailored to individuals' preferences, are expected to become widespread due to end user demand and thanks to the increasing mobile network capacities. This calls for further research on media consumers' current and future behaviour.

Johan Winbladh, digital media project manager at TV 2

My interview with Johan Winbladh focused primarily on two competing song contests illustrating current and near-future trends in interactive TV in Denmark: *X Factor* (Danish version of UK's *The X Factor*) aired on DR1 since 2008, and *Voice - Danmarks største stemme* ("Voice - The Biggest Voice of Denmark", Danish version of *The Voice of...*) aired on TV 2 since 2011. In both shows, contestants are evaluated by a set of judges (or coaches) and the audience based on their singing performance, until one contestant is declared winner. The entire process spreads over a number of phases during which contestants are eliminated. Although similar in the broad principle, the two shows differ on the following points:

- Applications are widely open in X Factor (5000+), while Voice requires a substantial initial singing level and accepts a limited number of applications (about 150).

- During the first round of selection, X Factor contestants are openly evaluated by judges who selects who among the contestants qualifies for the next stage; while the performance of Voice contestants is blindly evaluated by coaches, after which contestants themselves select a coach among those who showed interest in their performance.
- X Factor unfolds in two phases: selection and live performances; Voice includes battles in-between.
- As a result, Voice's broadcast lasts longer than X Factor's (fourteen weeks instead of eight).

Starting with discussing X Factor, Winbladh notes that the audience is already engaged with such shows and therefore further development of the interaction is natural and relatively straightforward. The interactivity surrounding the show goes through a dedicated website[4], as well as YouTube and Facebook, each having a different purpose. From a broadcaster perspective, Facebook is easy to integrate and control as it can link back to the in-house content. On the contrary YouTube is harder to manage as there is less to no such link back. Most of the content is uploaded illegally and competes with the legal content available on the dedicated website. However this illegal content helps creating an important buzz around the show and thus cannot be ignored or dismissed.

In comparison, Voice integrates 12 platforms (Youtube, Facebook, Twitter, iTunes, Spotify, etc.) in addition to its dedicated website[5] for its promotional and community building campaigns. Furthermore, all contestants in the show are required to brand themselves using primarily Facebook and Twitter and build a fan base community around them in order to create a dialogue with the audience. The interactive platforms (Facebook, Twitter, iTunes, etc.) are embedded in the dedicated website, and the audience is not particularly instructed on how to use them. The use of Facebook is quite extensive (Voice's Facebook universe spreads across more than 50 pages), and reflects the Danish active behaviour on the platform. Comparatively, the use of Twitter during Voice is not representative of the country's usual activity on the platform. In Denmark Twitter is not very popular, with 55,000 users reported in 2011, according to the Danish web analysis portal Overskrift.dk[6], which corresponds to a mere 1.5% of all 15-64 years old Danes. Winbladh explains that the usual ratio of Twitter over Facebook users in Denmark is about 1:50 (i.e. fifty comments are posted on Facebook per one tweet). However during the show, this ratio comes down to 1:4, with few topics generating as much activity on both platforms. This unusual behaviour has been triggered by the production team, who encouraged the contestants and the coaches to use Twitter to comment on the sequence of events as they happen during the show.

Another important element characteristic of Voice is the inclusion of the backstage room in the live broadcast. Between performances, contestants

[4]X Factor: http://www.dr.dk/dr1/xfactor/ (February 24th, 2012).

[5]Voice: http://v.tv2.dk/ (February 24th, 2012).

[6]Overskrift: http://blog.overskrift.dk/2011/12/21/twitter-i-danmark-2011/ (February 24th, 2012).

stay in this room where they discuss the ongoing events, are interviewed by journalists, and interact with the audience via online social networks. Large screens placed on the walls display comments by viewers, and the production team includes a number of peeks at the backstage room during the live broadcast flow. This, according to Winbladh, is part of the *Prepare, Talk, Back to the web* strategy of each Voice broadcast:

Prepare This short first stage happens upfront the broadcast and consists in advertising for the show by reminding the audience about Voice's web portal and Facebook page, the Twitter hashtag and the mobile app.

Talk During the broadcast, most of the focus is on the show, with few pointers toward the interactivity platforms.

Back to the web After the broadcast, the audience is directed to the supporting social media to access further content and engage in discussions.

This model has been previously rejected as it is said to disrupt the programme flow, to "break the magic", as it is assumed that talking on Facebook is not content. A simple rule of thumb is to limit intrusions (such as information banners) to 4-5 times per hour of show. However Winbladh argues that when pinpointing the correct moments, it is possible to include 10-15 of such "interruptions" without disturbing the programme. Furthermore, other trials with interactive TV narratives applied to drama, news and documentary programmes have shown encouraging results at engaging the audience with the shows (Ursu et al., 2008).

The discussion then focused on the worthiness of investing in such level of interactivity for broadcasters. Despite the broadcasters confidence that the sole quality of their content will attract viewers, experience has demonstrated the importance of an engaged audience in broadening the number of viewers. Programme ambassadors are especially important for promoting the content. According to Winbladh, attracting the rest is a matter of turning the content into "*a must have content, and to do this you need to make people talk about the programme. Social media is a great platform to make content unavoidable.*" Winbladh quotes a respondent from an in-house user survey: "*If my friends were not talking about it, I wouldn't engage with the show*", before adding that "*the process takes years, but it works and now the tools are available*".

Case studies like Voice are good for broadcasters in terms of image, and it contributes to creating a larger and more loyal audience. However it takes trials and error to build on successes, and broadcasters are not willing to take risks except for rare occasions. As an example of such exception, TV 2 invested in Voice to learn from it in terms of platforms and tools. In this case, the blue ocean strategy adopted by the station (as described in broad terms in Kim & Mauborgne (2005) and specifically in the case of social TV in Kastelein & Rempt (2011)), turned Voice into a strong advocate for interactivity around TV entertainment. Winbladh believes that adapting the concepts to other shows or genres (such as sports or children programmes) should be straightforward.

Current and future trends in Japan

This section is primarily based on an interview of Ryuko Furukawa, cross-media manager at tv asahi, leading national commercial broadcasting corporation (Furukawa, 2011). One of the main focus points discussed during the interview was the organisation of the corporation with regard to cross-media content production and distribution. In 2008, tv asahi adopted an integrated production infrastructure under the lead of Furukawa-san's Cross-Media Content Business division. "*Traditionally, the production of a specific programme is divided according to the platform of distribution (Net, print, mobile, DVD, etc.). Now the Production division makes programmes and discuss with Content Business on which platform the programme should be released. Then teams are formed by platform.*" This reorganization followed the evolution of media consumption. First content was made available on Internet via a web portal, then and mobile phones, and finally movies were made available on both Internet and mobile. The widespread user behaviour of accessing content via various media further motivated the adoption of this production model. As a result, "*the Internet and mobile teams are now planning together with the broadcasting team*". Even though, tv asahi doesn't have a mobile team as such. In fact, most mobile Internet news are made by newspapers or broadcasting companies, and in tv asahi's case, the Internet team provides content for both desktop and mobile. A generational gap also exists inside broadcasting corporations, creating disagreements between the importance of traditional TV and the development of new platforms. Another organizational challenge for large Japanese media corporations is the division between the holding company and its subsidiaries. For instance tv asahi is owned by Asahi Shimbun (which produces the second most circulated national newspaper), and collaboration between the two are still rare. Joint projects started only around 2010; however such projects are expected to become more common in the future.

Concerning media usage in Japan, Furukawa-san notes a generation gap in media consumption: older people mostly watch television at home while younger people tend to watch more content on the Internet an mobile devices. Being pragmatic, Furukawa-san comments that "*broadcasters are happy as long as people watch their content, whichever terminal they use*". With regard to television, Japan had an adoption rate of 100% in 2009 (Leckner & Facht, 2010), and the Japanese reported watching TV as their preferred leisure activity (OECD, 2009). Television is thus an important part of Japanese everyday life, and even if it is expected that TV as a medium will surely evolve in the near future, it will certainly not disappear. More region-specific as Japan is frequently subject to earthquakes, television also plays a vital role in emergency situations. The March 11th, 2011 catastrophe and following crisis tragically illustrated the importance of TV in case of natural disasters. In fact, despite the rise of social media as communication channels (as witnessed for instance in Hjorth & Kim (2011)), traditional TV broadcasts play a major role in disseminating trustworthy information, as documented for previous crisis in Taylor & Perry (2005). As a concluding remark on the topic of mediated crisis communication, it seems that today's appropriate response should encompass both traditional and new media in order not only to reach the widest

audience (Falkheimer & Heide, 2009), but also to limit medium bias in information reception (Schultz et al., 2011).

The interview then moved on from television to mobile. Furukawa-san expects smartphones to overtake 'Galapagos' mobiles around 2012-2013 as smartphones are more suitable for consuming media due to their bigger screen and improved usability. She then described the concept of data broadcasting, which consists in embedding information (programme related or not, such as news, weather, traffic or emergency information) within TV broadcast to be accessed on mobile devices. This principle assumes that all future mobile devices will be connected to Internet, and today this type of interaction is limited to quizzes. For instance, tv asahi and NHK offer interactive quizzes modelled after Holland's *Test the nation*[7]. In Japan, participants can answer the questions from computers, mobile phones, terrestrial digital broadcasting and One-Seg services (tv asahi, 2007). For instance in 2008, tv asahi and Artificial Life Inc. have partnered and released an interactive mobile participation TV show, during which up to 100,000 viewers control 3D animated avatars and participate in a quiz game using their mobile phone[8]. Further elaborating on the interaction between broadcasters and their audience, Furukawa-san remarks that despite these attempts to develop interactive TV services, and much like in Denmark, Japanese radio stations offer high interactivity with their audience who can easily call the station and take part in shows or submit comments. As such, the Japanese radio is much more interactive than TV.

Concerning this issue, Furukawa-san expressed her wish to see more interaction with the audience. Only few specific TV shows integrate user-generated content (UGC) in their production, and most of the submitted content is recorded again by the production team who aims at "controlled perfection". As examples of such shows relying on UGC, Furukawa-san mentions "nanikore chin hyakkei"[9], a weekly entertainment show for which viewers submit photos or videos depicting funny situations, and a classical music programme for which the audience submit videos of themselves conducting an orchestra, in the hope of directing a real orchestra during an annual show. Additionally, NHK sometimes uses videos taken by its audience and displayed as a 'corner video' (displayed as a small insert in one corner of the video broadcast) to support a topic coverage. Specifically, Furukawa-san emphasized the important role UGC could play during dramatic events like the March 11th earthquake and following nuclear crisis. Compared to the coverage of the Kobe earthquake in 1995, where journalists had to travel to retrieve information and conduct interviews, it is now possible to interview from a distance and retrieve textual and video material from citizens. Similarly to the development of citizen journalism in other countries (for instance in Finland, as described in Väätäjä et al. (2011)), the role of TV stations would be to verify the facts collected from individuals.

[7] Test the Nation is a national TV quiz show during which viewers answer questions to test their IQ. The concept exists in more than 25 countries worldwide.

[8] Example from MoPA-TV 3.0: http://www.mopa-tv.com/showcases/show/111-TV-Asahi (March 3rd, 2012).

[9] ナニコレ珍百景 (nanikore chin hyakkei): http://www.tv-asahi.co.jp/nanikore/ (March 8th, 2012).

Finally, Furukawa-san explained how tv asahi interacts with its audience through three types of workshops. Firstly, a series of "TV puzzle" workshops is recurrently organized in the TV station's premises. During these workshops, a number of tv asahi's staff (including executives and programme directors) meet with members of the public as well as researchers from The University of Tokyo. Groups including all three categories of participants are formed and engage in discussions and creative activities. An example of such workshops is described in further detail in Section 5.3. Secondly, TV directors visit primary and high schools and introduce students to the work at TV stations. tv asahi is heavily involved in such awareness campaigns as they happen two to three times weekly. Finally, seminars about the TV station's work are organized every 2-3 months, during which content producers or technical directors explain their activities to a group of 40-50 members of the general public. Even though these dissemination activities involve most of the station's staff who is thus exposed to questions and comments from the public, their impact on the broadcast content is unclear. According to Furukawa-san, the main purpose of this constant interaction between staff and audience is to open the station to the public and provide a clear image of what happens inside the broadcasting corporation.

This push toward more dialogues between broadcasters and the public reflects a cultural shift in ICT economies where content is not only pushed to people but also generated by the masses. Additionally, the acceptance and adoption of media technology depends on historical and cultural factors, which technology developers need to carefully consider when developing new products. To understand these mechanisms, the next section reviews the academic literature on cultural aspects of convergence, taking Henry Jenkin's work as a departure point.

2.4 Users

This section investigates the user perspective on new media, and especially how the convergence between television and mobile technologies is experienced in highly connected societies. It relies on an online survey conducted in the spring of 2012, aiming at discovering everyday practices with televisions and mobile phones in Denmark and Japan, two countries with high technology penetration rate. The survey explored mobile phone and television usage separately as well as jointly, as in mobile television and in a typical second screen setup. By "second screen" we refer to any device (smartphone, tablet, laptop) that allows TV consumers to interact with TV content displayed on a "primary" screen (typically a home television set). This definition holds for the subsequent chapters. The survey was intentionally short (17 topical questions in addition to three demographics-related ones) and presented in three languages (Danish, Japanese, and English). It ran for seven weeks between March and April 2012 and was answered by 116 Danish and 102 Japanese respondents. Gender parity was respected in both regions, however the age ranges differed slightly in the sense that Danish pupils under 20 years old participated in the survey, whereas this population is not present in the Japanese panel. A summary of the results presented in the following sections is moreover available online[10], which allowed survey participants to receive feedback from the survey shortly after it ended. A visual summary of the demographic information about survey respondent is provided in Figure 2.2. Then the following details the main findings from the survey and compares the two regions, while the methodology employed is described and discussed in Section 5.1. In the following paragraphs, all differences expressed related to age, gender, or country are statistically significant at a level $p < 0.05$.

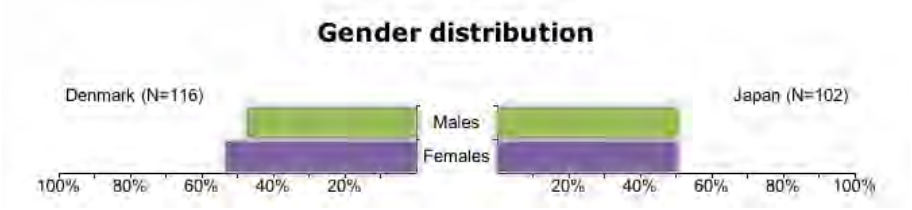
The use of mobile phones

Survey participants were first asked to describe the type of mobile phone(s) they carry around with them. As depicted in Figure 2.3, the vast majority of Danes and Japanese only use a *personal device*, while few use both a *personal and a professiona*l one. This result is consistent across country and gender, but significantly varies with age in Denmark: the 25 year old and younger Danes only use personal devices, contrasting with the other age groups.

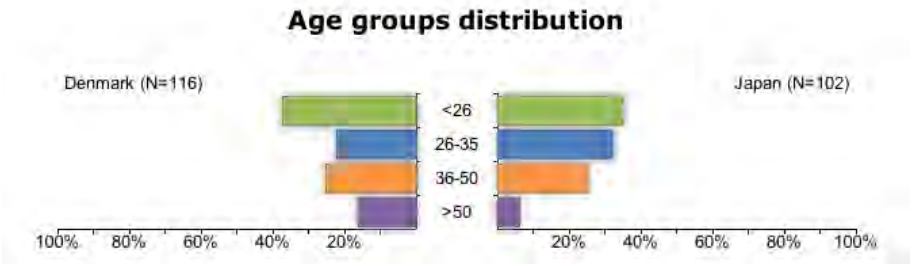
When it comes to everyday use of mobile phones, Japanese *surf Internet*, *check their emails or calendar* and *use their mobile phone's camera* significantly more often than Danes do, as Figure 2.4 shows. Not surprisingly, both populations reported surfing Internet and checking emails more often than they download content for or take pictures with their phone. Both populations also reported downloading content such as ringtones, games and apps in similar proportions and rarely, especially among respondents above 50 years old.

Gender appears to have no incidence on the frequency at which Danes and Japanese perform these activities, except when it comes to downloading content, which seems to be a significantly more masculine activity in Denmark.

[10] Survey results: kom.aau.dk/~amf/cSurvey/results.html (April 15th, 2012).



(a)



(b)

Figure 2.2: Summary of survey demographics: (a) Gender and (b) Age group distributions.

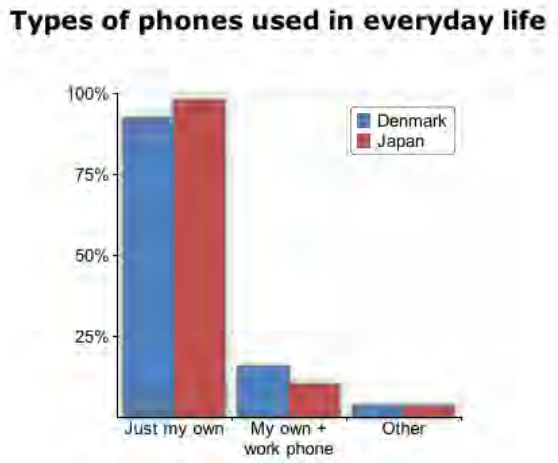


Figure 2.3: Types of mobile phones carried by Danes and Japanese.

Additionally, the following differences across age groups appear in the frequency at which each activity is performed.

Internet surfing

- Danes aged 35 and under access Internet on their mobile phone more often than Danes above 50.
- Japanese under 26 use mobile Internet more often then any other age group.

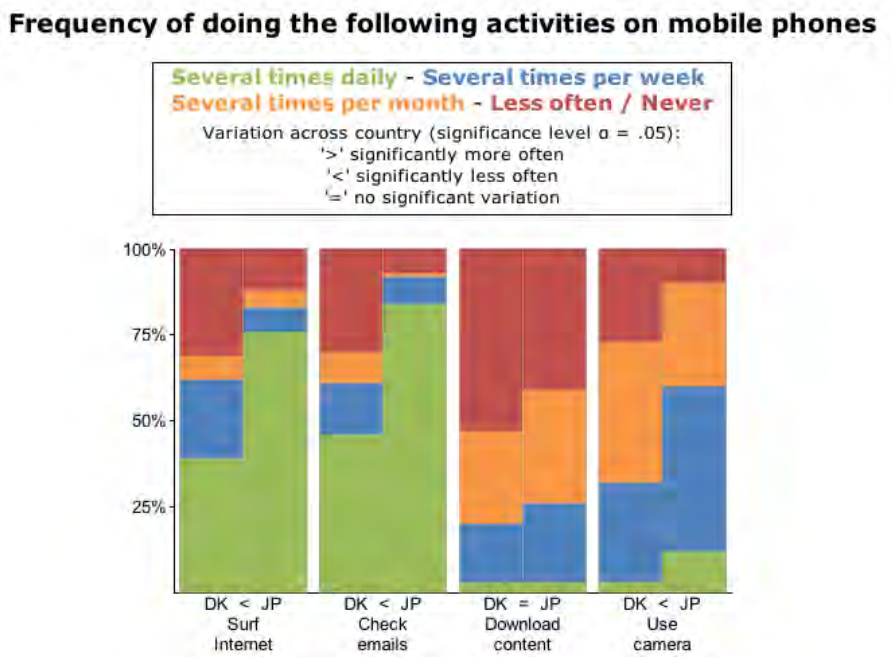


Figure 2.4: Frequency distribution of common mobile activities in Denmark and Japan.

Checking email/calendar

- Danes between 26-35 check their emails on their mobile phone more often than Danes under 26.
- Japanese under 26 do so more often than Japanese above 50.

Downloading content

- Danes under 26 download content for their mobile phone more often than any other age group.
- In Japan, they do so more often than people aged 26-50.

Taking pictures

- Danes above 50 use their mobile phone's camera less often than any other age group.
- Japanese between 26-35 use their mobile camera less often than Japanese under 26 and between 36-50 years old.

As depicted in Figure 2.5, important buying factors are also found comparable in both countries: *functions*, *design* and *price* are the top three criterion influencing device acquisition. On the contrary experience continuity (similarity to previously owned phones) and social conformance (similarity to devices owned by colleagues and friends) are of negligible importance.

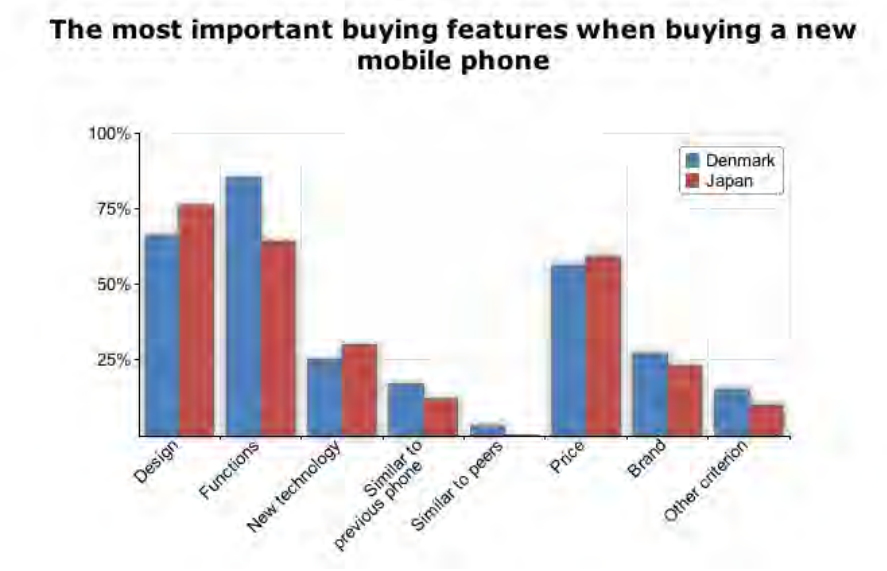


Figure 2.5: Frequency distribution of common mobile activities in Denmark and Japan.

These buying criterion are coherent with what respondents reported liking and disliking about their mobile phone, even though differences exist between the two countries. Indeed the vast majority of Danes like mostly the phone's functions (calling, accessing Internet) and applications in the case of smartphones, whereas Japanese are mostly positive about the design of the phone, slightly more than its functions. The importance of mobile phone functions in the perception of mobile phones had been previously established for Japanese and North Europeans (Swedes) in Baron (2009), through instant concept association not related to like/dislike feelings as it is the case here. As shown in Figure 2.6, in both countries issues related to performance and usability are the main sources of dissatisfaction with mobile phones. The phone specifications are also a source of concern for Danes.

Finally, Danish and Japanese respondents expect to react slightly differently in case they could not use their mobile phone any longer. Among the six basic emotions identified by Ekman et al. (1972) and Ekman (1992), and validated cross-culturally (Ekman & Friesen, 1971, Ekman, 1989, Elfenbein & Ambady, 2002, Sauter et al., 2010), that is *anger*, *sadness*, *surprise*, *joy*, *disgust* and *fear*, both Danes and Japanese chose *sadness* as the emotion they would most likely experience if they were suddenly deprived of mobile phone. However, while the sadness experienced in Denmark would be tinted with *anger*, Japanese sadness would be mixed with *disgust*. The varying responses in Denmark and Japan concerning disgust might be partially explained by how this feeling is interpreted in the two cultures. The Japanese translation of disgust as "うんざりする (unzari suru)" includes the notion of getting tired of something, of losing interest and getting bored, while the Danish "afsky" reflects loathing and aversion. As depicted in Figure 2.7, surprise, fear

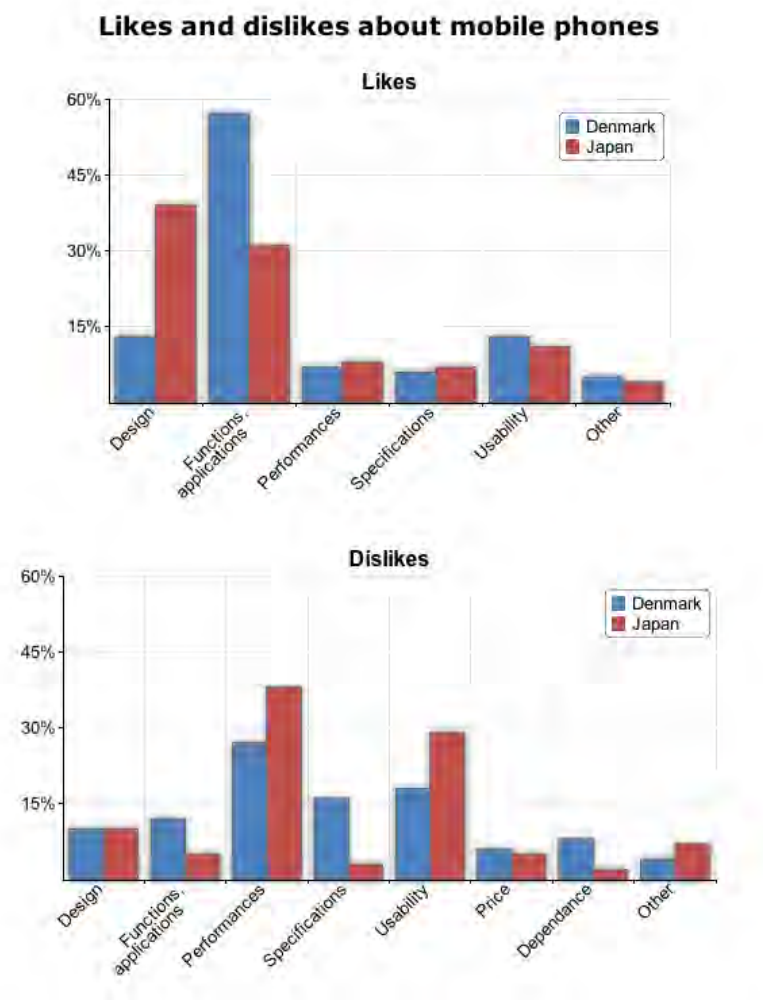


Figure 2.6: Most and least preferred features of mobile phones in Denmark and Japan.

(and anger in the case of Japan) follow closely these feelings. Furthermore, participants mentioned a large amount of additional feelings they anticipate to experience if they were to no longer have access to their mobile phone. Here again the two populations vary slightly in their answers. Danes cited in majority irritation and a mixture of powerlessness, frustration and loss, while Japanese referred to a combination of anxiety, impatience and trouble. It could be argued that the consensus reached by participants on those emotions cited spontaneously makes a compelling argument for their accuracy at describing how one might feel without mobile phone, in complement to the basic emotions.

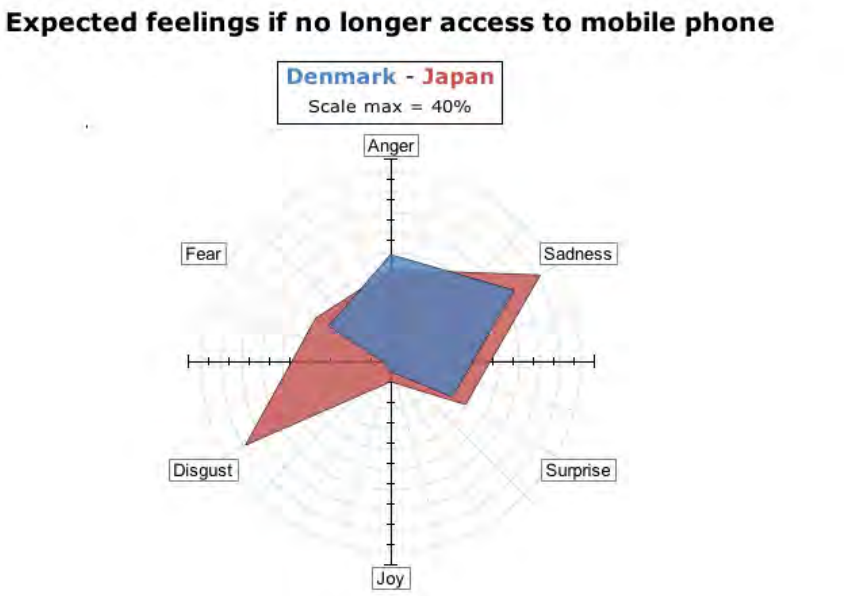


Figure 2.7: Basic emotions likely experienced by Danes and Japanese with no longer access to their mobile phone.

TV/video consumption habits

Survey respondents from both regions reported similar amounts of daily video consumption, as depicted in Figure 2.8. *Videos* is used here in a broad sense and includes live and recorded TV, videos from online services or stored in a personal archive. The survey shows that 52% of Danes and 48% of Japanese spend on average 2-4 hours daily watching such types of video content, while 43% and 48% do so for less than one hour. Only a small fraction of respondents (5% and 4%) reported dedicating more than four hours per day consuming videos. No gender effect appeared in the answers, and only the Danish population displayed significant age differences: Danes below 35 reported watching significantly more video content than their older peers.

The type of device used to watch this video content was also investigated. Participants should indicate the frequency at which they consume videos on a home TV set, a computer, and a mobile device. Overall results (see Figure 2.9) show again very similar trends in Denmark and Japan, with *home TV* sets being the favoured devices for video consumption, shortly followed by computers, mobile devices being less often used. The amount of use for each device is in line with current global trends, as reported by Nielsen Media Research[11]. However a closer look at these results brings up interesting findings. For instance Danes above 50 use the home TV set significantly less often than between 26 and 50, and Japanese women use the TV significantly more than Japanese men. With regards to PC use, males in both countries use such

[11] Nielsen, *Global Report: Multi-Screen Media Usage*: http://blog.nielsen.com/nielsenwire/global/global-report-multi-screen-media-usage/ (June 22th, 2012).

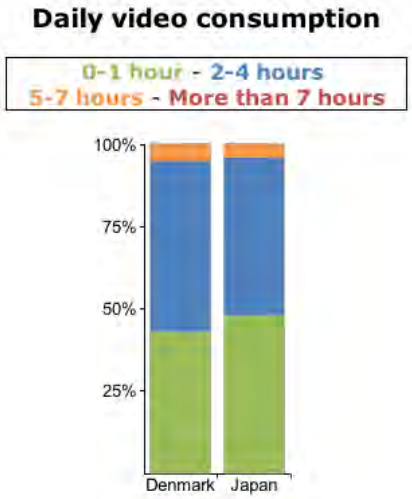


Figure 2.8: Duration of daily video consumption in Denmark and Japan.

device significantly more often than females, and Danes below 35 use it significantly more than their elders. Finally, Danish men watch video on mobile devices significantly more than Danish women, and Danes between 26-35 years old do so significantly more often than Danes above 50 years of age.

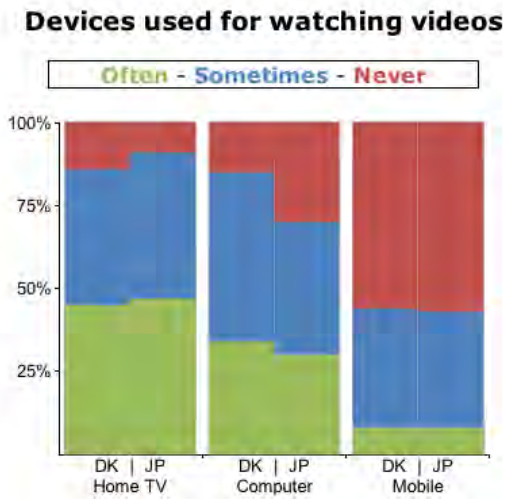


Figure 2.9: Distribution of video consumption across devices.

With regard to the type of content watched on television, *news* is clearly the most popular genre watched in both Denmark and Japan, with 70% and 79% of respondents mentioning it, respectively. Then (as depicted in Figure 2.10), while *movies* is equally mentioned in Denmark (69%), *entertainment and re-*

ality shows appears to be the second most popular genre in Japan (67%). Interestingly, series and sitcoms are mostly popular in Denmark, and while documentaries are often watched in both regions, talkshows are seldom mentioned.

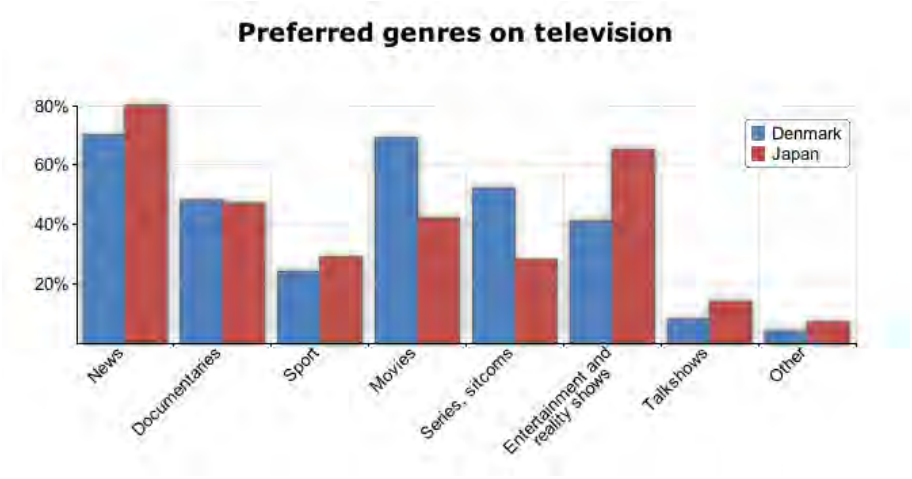


Figure 2.10: Preferred TV genres in Denmark and Japan.

Similar to with mobile phones, respondents were asked to imagine that they had no longer access to their television. Ekman et al.'s six basic emotions were again used as a basis for the analysis, which yielded slightly different results than for mobile phones. As Figure 2.11 shows, Danes expect to experience a mixture of *sadness* (22%), *anger* (19%) and *surprise* (18%), whereas in Japan, *sadness* (30%) would be tinted with *disgust* (16%) and *surprise* (13%). Similarly than with mobile phones, disgust might be understood slightly differently in Japanese (the translation here being close in meaning to irritation) than in Danish (loathing, aversion). Additionally, an especially large number of respondents (34% of Danes and 48% of Japanese) found that none of the six basic emotions suggested represented well their expected feeling in this situation. A potential explanation is actually the lack of reaction that would experience the respondents with no longer TV access, as suggested by the additional emotions freely cited by participants. Indeed, indifference was explicitly mentioned by 8% of Danes and 11% of Japanese. In addition, irritation was cited by 11% of Danes.

Finally, respondents described what they like and dislike about their television. Answers collected in Denmark differed visibly from those collected in Japan, as illustrated in Figure 2.12. The two predominant sources of positive feedback in Denmark are the content (cited by 28%) and the purpose of watching TV (23%), which includes catching up with news and being entertained. In Japan however, the TV's performances are the main source of satisfaction with television (30%), followed by content (18%) and purpose (14%). The two populations also differ in the features they dislike about TV: it is considered a time waster by 22% of Danes, and the content available is

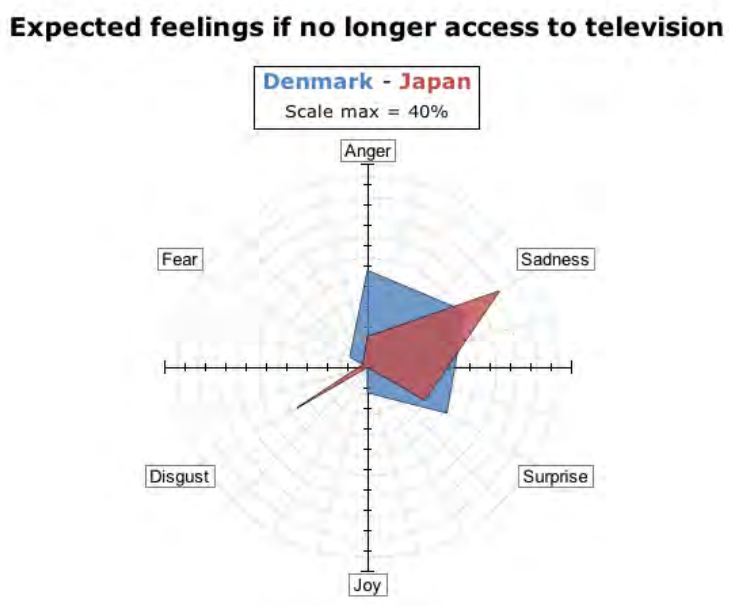


Figure 2.11: Basic emotions likely experienced by Danes and Japanese with no longer access to their television.

a source of dissatisfaction for 20% of them. Japanese complain mostly about the content available (32%) and the specifications of their TV set (26%). As it could be expected, television content holds thus an ambiguous yet critical role in the TV experience, as it is the source of both positive and negative feelings. Tensions were also visible in comments in which TV was considered a time waster: Often TV is appreciated for its relaxing or informative purpose but watchers tend to get caught up and keep on watching even though they lose interest in the programme, which leads to frustration.

Mobile TV use

The survey briefly investigated mobile TV usage, asking respondents to report their interest in watching television on their mobile phone in various situations. As Figure 2.13 shows, in both Denmark and Japan, *commuting* time as well as *waiting* situations (for public transport, at an airport, or at a café) are the most likely situations for watching mobile TV. *At home before sleeping* is additionally considered a favourable situation for mobile TV consumption. These results are consistent with previous research, as introduced in sections 1.1 and 3.2. Danish respondents expressed more interest in watching TV on mobile phones while commuting, during short breaks at work and while waiting for public transports than Japanese. Somehow surprisingly, the younger population expressed as limited an interest in watching mobile TV in these situations as their elder did. The only age effects noticed are the following: Japanese aged between 36-50 are less interested in mobile TV during work breaks than Japanese aged 25 and younger, and above 50; and Danes between

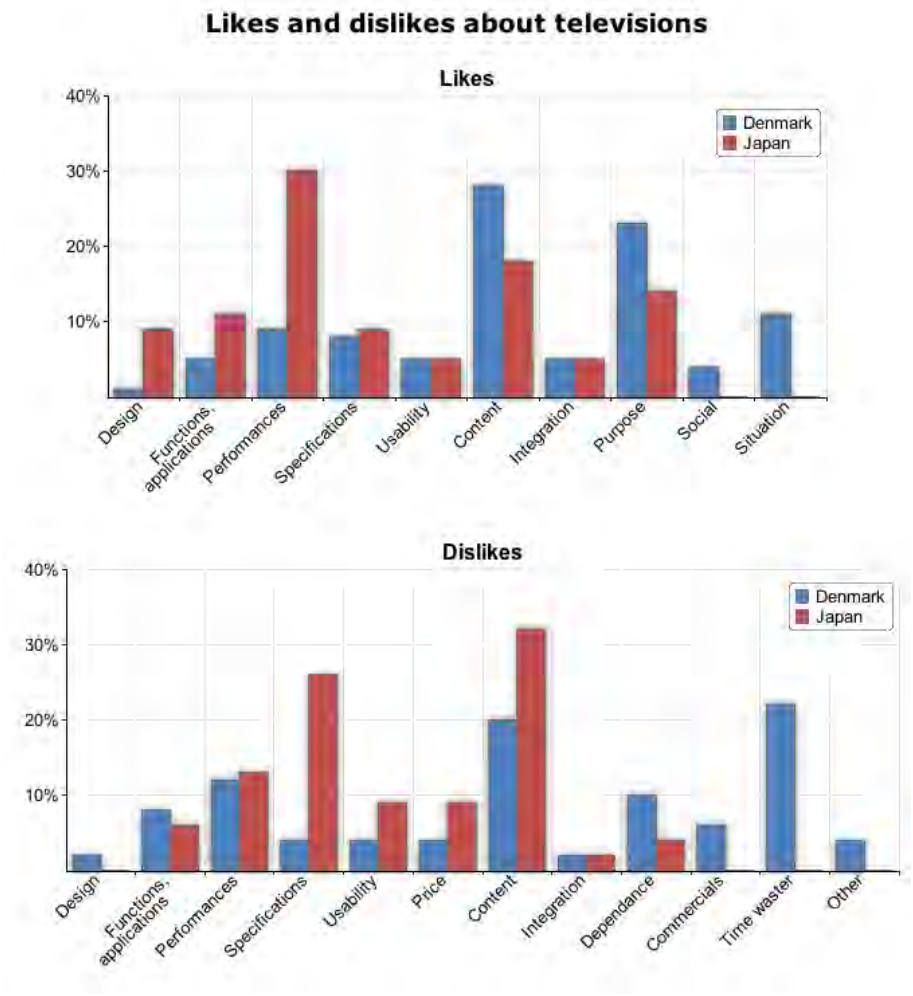


Figure 2.12: Most and least preferred features of televisions in Denmark and Japan.

26-35 are more interested in mobile TV while waiting for public transports than Danes younger than 25 years old.

As seen previously, interest in mobile television remains quite low, at least considering the situations investigated in the previous question. Respondents were then asked to name additional situations in which they are interested in watching TV on a mobile device. As depicted in Figure 2.14, Danes and Japanese have different interest in mobile TV: travelling and waiting situations are prioritized in Denmark by respectively 24% and 21% of those who cited other situations of interest. This further confirms the results to the previous question. It should also be noted that 26% of Danes explicitly mentioned not being interested in watching television on mobile phones. Comparatively in Japan, mobile television is appealing in case of emergency situations and

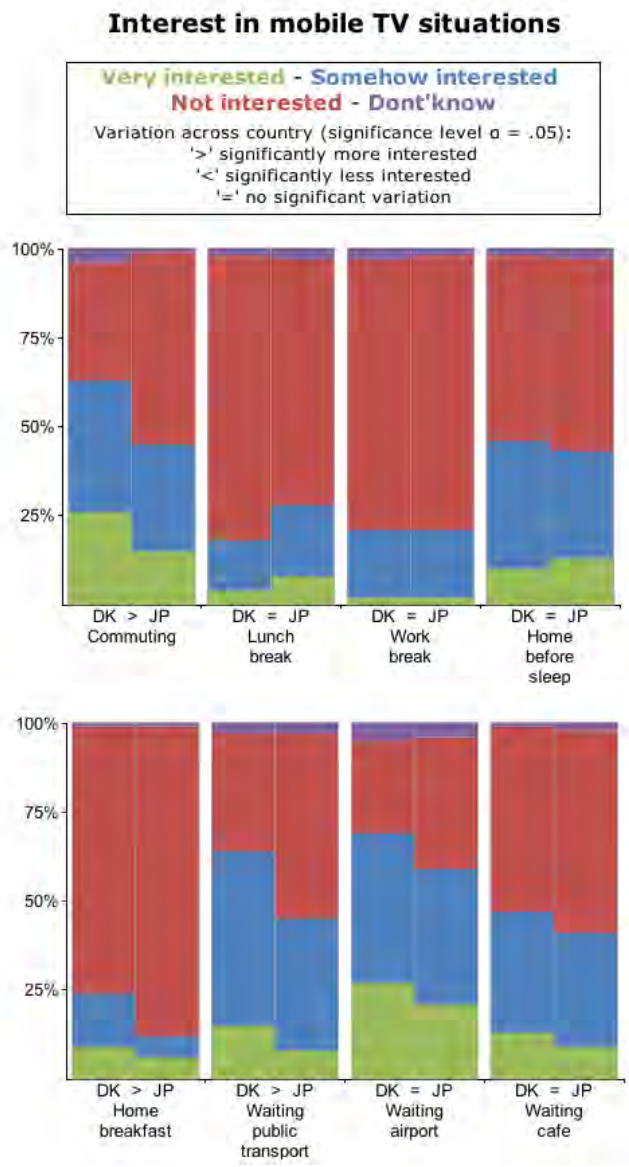


Figure 2.13: Expressed interest in watching TV on mobile phones in various situations.

to be informed in case of a disaster occurring. Additionally, mobile TV is seen as a potential companion during specific activities, especially at home, such as taking a bath.

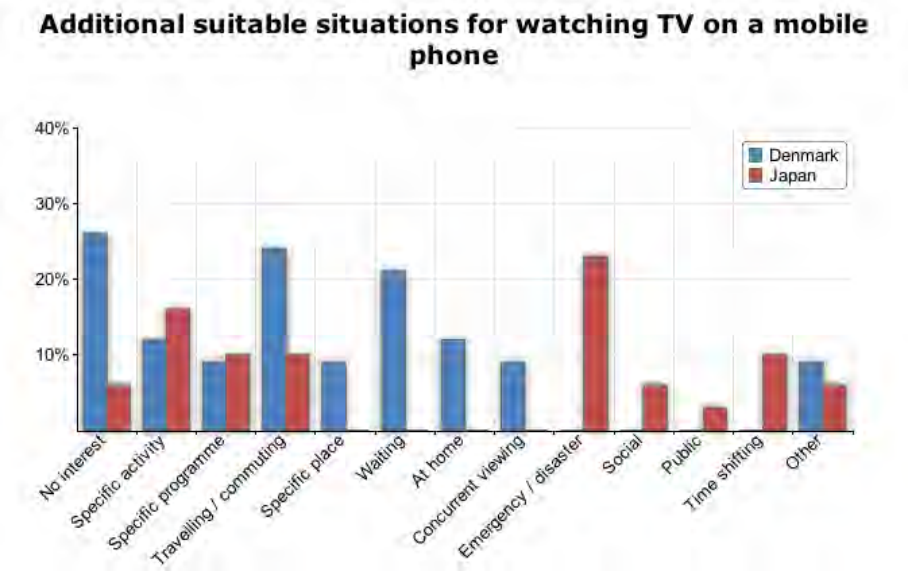


Figure 2.14: Additional situations of interest for watching mobile TV.

Second screen viewing practices

The final part of the survey addressed the use of a mobile device in front of TV, as a second screen. First, survey participants were asked to indicate whether they use other electronic devices (such as mobile phones, tablets, fixed or mobile computers) while watching television. As depicted in Figure 2.15, this appears to be a common practice among both Danes and Japanese, as about half of all respondents reported doing so often, and more than one in three sometimes. Danish respondents aged 50 and above engage in such media multitasking less often than members of the other age groups. Once again, the findings are comparable across region and gender.

The survey then investigated the activities one can engage in while the TV is on. First, respondents were to indicate how often they discuss content with co-viewers, check their emails, surf Internet, and chat with remote friends. Overall, *checking emails* and *surfing Internet* are the most popular activities in both regions, with more than three respondents in four reporting doing those at least sometimes (see Figure 2.16). However, Danes chat with remote peers more often than Japanese do. Gender differences also appear in Japan: women discuss content with co-viewers and check emails more often than Japanese men. Moreover, age differences are found in Denmark: Danes above 50 years old surf Internet less often than any other age group, and when it comes to chatting online, young Danes under 25 do so more often than Danes above 35.

When asked to cite other activities they usually engage in while watching TV (including non-media related tasks such as cleaning or cooking), 30% and 47% of Danish and Japanese respondents mentioned eating, followed by housework (22% and 19%). As illustrated in Figure 2.17, communicating

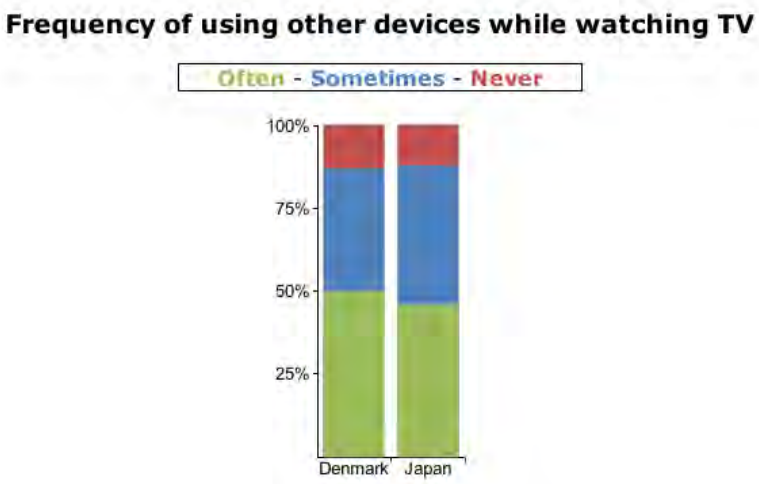


Figure 2.15: Frequency of second screen use in Denmark and Japan.

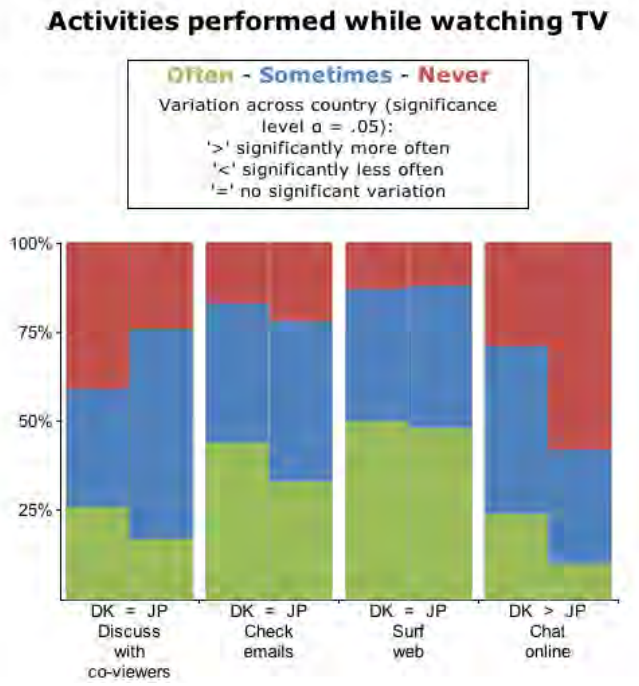


Figure 2.16: Frequency distribution of specific second screen activities in Denmark and Japan.

(via mobile phones), and playing games (also on mobile devices) are other frequent activities in Denmark, as they were mentioned by 20% and 19% of Danish respondents. In Japan however, cooking (16%) and working / studying (16%) follow in the list of activities conducted while watching TV.

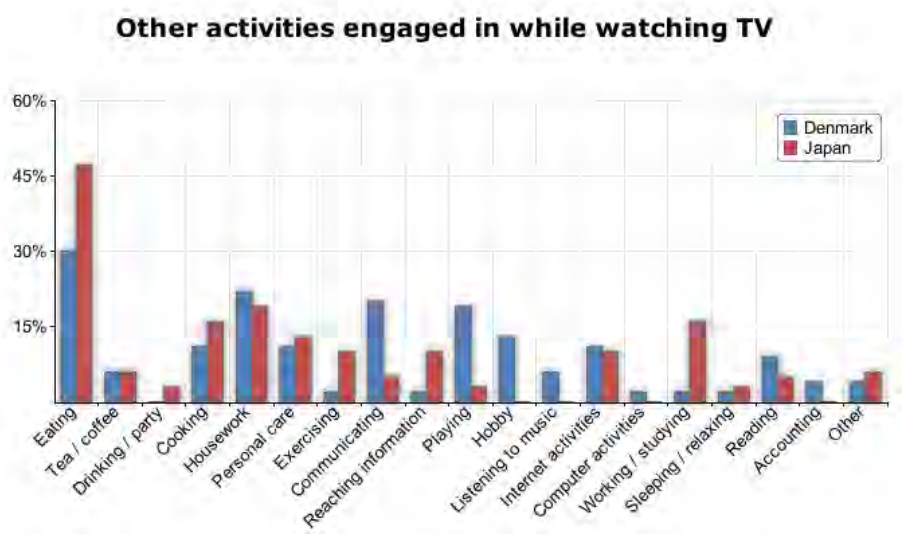


Figure 2.17: Additional second screen activities performed in Denmark and Japan.

Additionally, respondents were prompted for their interest in a selection of second screen activities, by expressing how likely they would perform these activities if their television was connected to a mobile phone or tablet computer. Overall, *checking other channels* and *accessing more information* about the current TV programme are the two second screen activities Danes and Japanese alike most likely envision to engage in while watching TV. As shown in Figure 2.18, regional differences appear only concerning interest in checking other channels with the secondary device. Danes reported being more likely to do so than Japanese. Gender is a source of differences regarding interest in participating in a poll related to news, and to send comments to a TV show reviewing consumer products: in both cases, Danish males are more likely to engage in those activities than Danish females. Finally, Danish age groups differ in how likely they would send comments to a consumer product show (Danes between 26-35 are more likely to do so than Danes below 25 and above 50 years old), access more information about the content of the show being watched (Danes between 26-35 are more likely to do so than all other age groups), and chat with friends about the programme being watched (Danes 25 years old and younger are more likely to do so than Danes above 35).

Finally, a few participants mentioned other activities they would be interested in for second screen services. These include reaching more information about the current programme, which further emphasizes the finding from the previous question, as well as communicating with peers via social network. Specific functions appeared also relevant to participants, such as using the second screen as a remote control.

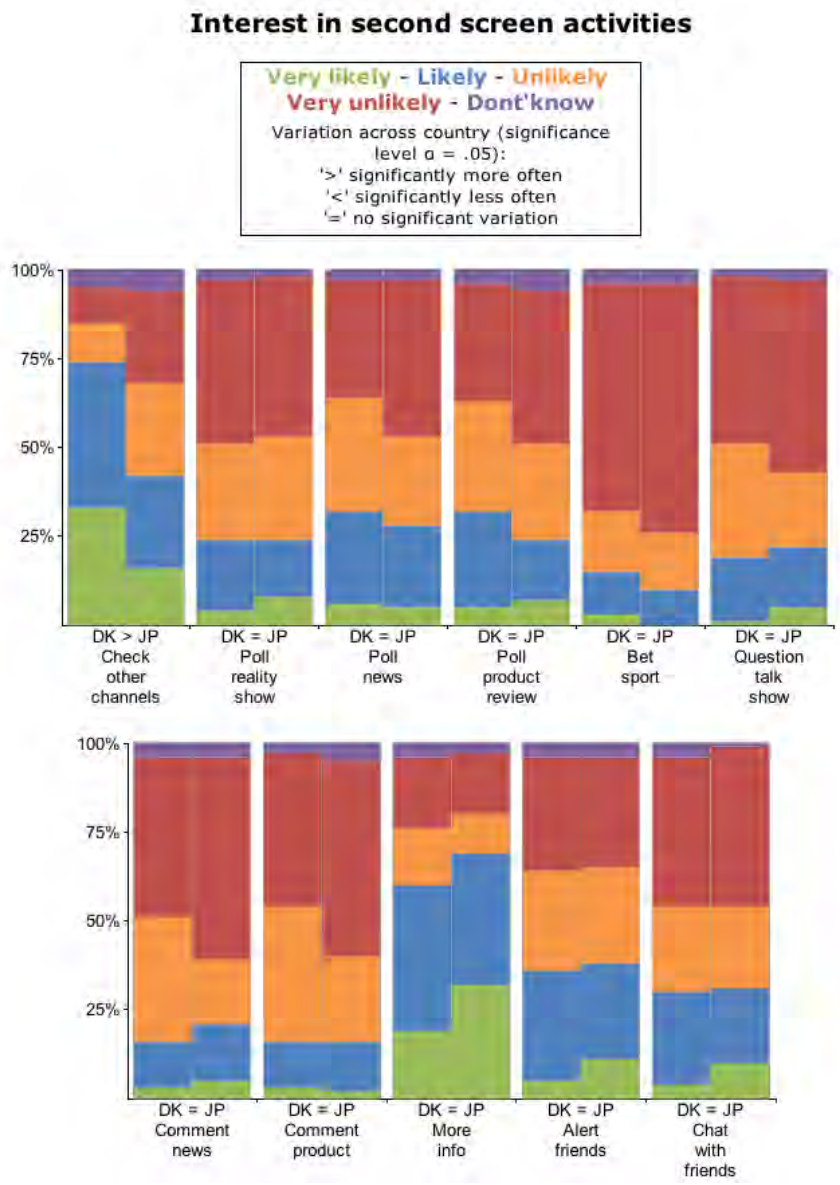


Figure 2.18: Expressed interest in second screen activities.

Concluding remarks on the findings

The answers collected through this survey on everyday media use in Denmark and Japan reveal similarities and differences with regard to how the two regions perceive and use mobile phones and televisions, and apprehend the convergence of the two technologies. In terms of current technology use, it is not surprising that the Japanese access Internet, check emails and use the phone's camera significantly more often than the Danes do. The similarity and low level of mobile video consumption in the two countries is however

surprising, considered the longer history of popular access to video content on Japanese handsets. Similarly, mobile television generated only a limited interest in both regions, and Danes actually expressed more interest in what could be considered typical mobile TV settings (such as commuting, or waiting for public transports), in which Japanese actually have the possibility to watch TV on mobile phones (and have been able to do so for about six years). Potential explanations include 1) the novelty effect on the Danish consumers who are starting to experience TV on the go, 2) the lack of valuable content on the Japanese mobile TV market, limiting the use and interest in the service as it is now, and 3) the lack of infrastructure for mobile TV on the commuting network within metropolitan Tokyo, the main area Japanese respondents are from.

As deduced from the answers concerning second screen television viewing, both the Danes and the Japanese are very active while watching television. They engage in both media and non media related activities, which confirms results from earlier studies about multitasking in general (Brasel & Gips, 2011, Tokan, 2011) and on the Danish population in particular (Thunø, 2011). For instance both Brasel & Gips and Thunø found that people involved in computer based activities while watching TV attend more to the computer than to the TV. Another interesting finding regarding media multitasking is the extent to which Japanese report working while watching TV compared to Danes. This can be explained through the lens of the early anthropological work by on polychronicity (preference for conducting multiple activities simultaneously) versus monochronicity (preference for finishing an activity before starting another one), showing that Japan is an exception in the developed countries in that it is inherently more polychron than monochron (although this statement has been contested, for example in Lindquist et al. (2001)). Regarding specific use of second screen activities however, only few of the suggested activities were considered at least likely to be performed by respondents. Checking what happens on other channels as well as accessing more information about current programmes have received the most favourable likeability scores, perhaps due to the ease to grasp and comprehend those activities without actual experience with them, compared to the other suggested hypothetical activities. Moreover, the high interest in news content on television reported by respondents from both countries and the interest in accessing news on mobile phones in those regions discussed in Westlund (2010) demonstrate the importance of this content genre for those two regions representative of ICT societies. This tendency comforts Wieland's argument for the role of news in second screen services. In the light of those findings, the next chapter will further explore the convergence of television and mobile technologies and how audiences make sense of this convergence.

Final draft

CHAPTER 3

MOBILE / TV CONVERGENCE

In the previous chapter we have established some aspects of media convergence from the viewpoint of various actors of the content delivery chain, mostly from a theoretical stance. This chapter adopts a more practical position and investigates convergence from the specific perspective of televisions and mobile devices. The findings from the various studies reported in this chapter support answering the second sub-research question I.b: *How do Danish and Japanese media consumers perceive the convergence of television and mobile technologies, and what are the opportunities and challenges for wide user adoption of services resulting from such convergence?* Specifically, the following sections report on 1) personal relationship between media technology and their users explored through participant generated drawings and a drama workshop, 2) opportunities and challenges for mobile television derived from task-based interviews, a remote survey, focus groups, and a usability study, 3) the feasibility of second screen applications based on user workshops, and 4) the issue of transferring content across devices evaluated through a usability study .

3.1 Personal televisions, personal mobile phones

This section reports the results from two ethnographic studies which aimed at exploring the personal relationship between mobile phone and television owners and these two media technology devices. Both studies were conducted first in Japan, and one was then repeated in Denmark. Fleury (2011, 2012) present the methods used in these two studies (further developed in sections 5.3 and 5.4). This section elaborates on the preliminary findings presented in these publications. The first study relied on participant generated drawings to explore everyday perceptions of television and mobile phones, as well as marking memories participants associate with these objects. The second study consisted in a drama-based workshop during which participants worked first individually on expressing memories and describing their

attachment to the technological objects, before creating stories in small groups and acting them on an improvised theatre scene. A short summary of demographic information concerning participants in both studies is provided in Table 3.1.

Table 3.1: Demographic information of the participants who took part in the two studies presented in this section.

	Study 1		Study 2
Country	Japan	Denmark	Japan
N	21	37	12
Male - Female	17 - 4	26 - 11	8 - 4
Mean age	36	24	26

The following reports the results from Study 1, which consisted in gathering four types of participant-generated line drawings. More specifically, the participants were instructed in the following terms:

1. Please draw the layout of your home in the space below.
   Place media devices (TV, radio, computer, phones, etc.) where they are mostly used.
   Indicate which media appliances you use simultaneously.

2. Please think about an impressive memory involving your television. ["an impressive memory" was orally described as "a marking memory that you can remember"]
   Try to illustrate what happened and the context in which it happened in the space below.
   You may use words to further explain the memory.

3. Please depict yourself and the mobile devices you usually carry around with you. ["depict" was orally explained as "drawing / making a visual representation"]

4. Please think about an impressive memory involving your mobile phone.
   Try to illustrate what happened and the context in which it happened in the space below.
   You may use words to further explain the memory.

Media use at home

First and similarly to the study in Brush & Inkpen (2007), participants were asked to draw the layout of their home, and to place media devices where they are normally used. The media equipment depicted in the drawings collected is quite consistent across countries. As illustrated in Figure 3.1, televisions are present in the large majority of the drawings, followed by computers (fixed and mobile), mobile phones and radios. Figure 3.1 should be interpreted carefully. The numbers are merely an indication of the types of device most often depicted in the drawings, and are by no means representative of the number

of devices owned by participants. Additionally, due to the ambiguity concerning for instance fixed versus mobile computers (both being often depicted as a square box labelled "PC"), it is preferable to avoid interpreting directly the quantities depicted in Figure 3.1.

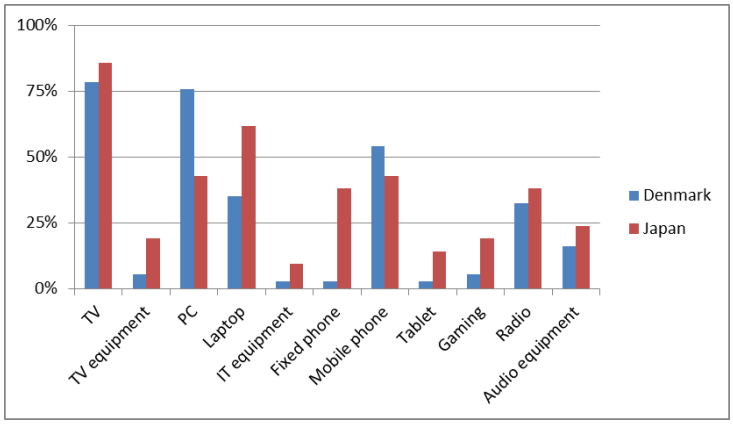
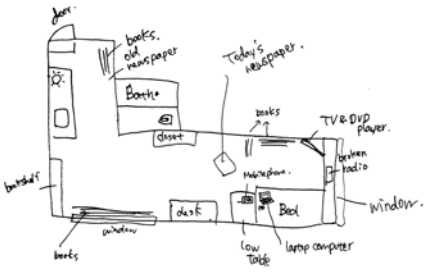


Figure 3.1: Types of media equipment depicted in participants' drawings.

Despite these analytical restrictions, it appears quite clearly from the drawings collected that televisions and computers are the center of Danish and Japanese in-home media life. They are sometimes connected to each other, or used simultaneously. In Japan more than in Denmark, computers are classified either as fixed (referred to as "PC" or "desktop") or as mobile ("laptop" or "notebook"). Figure 3.2 illustrates a home depiction from each country.



(a) Home depiction (Female, 28 - Japan).

(b) *Laptop and Hifi stereo at the same time* (Male, 22 - Denmark).

Figure 3.2: Illustrations of home depictions with various media equipment.

Even though all participants reported owning at least one mobile phone, only slightly less than half of them included mobile phones in their drawings. Japanese represented fixed phones more often than Danes, which can arguably be attributed to the age difference between the two populations of test

participants. Younger respondents are expected to use mobile phones more often than fixed ones, even though a fixed phone might be present at home.

Personal memories about television

The stories depicting memories related to television collected in Denmark and Japan can be classified according to the following three categories.

Device Drawings in this category depict events related to the device itself, either in terms of ownership, acquisition, or use. The Danish submissions in this category cover all three subcategories, while the Japanese ones are all related to situations in which TV is used. Figure 3.3 provides an example of a contribution to this category from both countries.

(a) *When I was 8~11 years old. I like TV very much. I sat nearby TV, changed channels using my toe skillfully.* (Female, 31 - Japan).

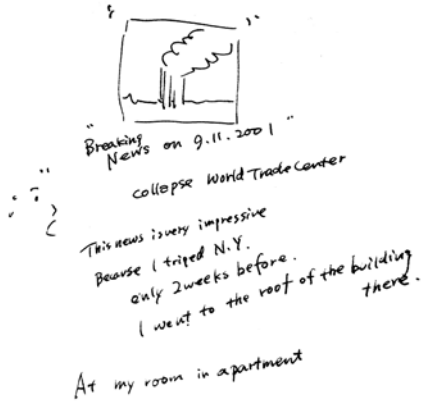
(b) *When we took our new TV home at the back of the cycle.* (Female, 22 - Denmark).

Figure 3.3: Illustrations of TV related memories associated with the device itself.

Content As depicted in Figure 3.4, Content related contributions are associated either with a specific genre (most often tragic news) or the action of producing material, participating in a show, or watching a specific show.

Social Submissions to this category focus on the social environment of the memory illustrated in the drawing. Friends, family members and strangers are equally represented in both countries. Two examples of such drawings are provided in Figure 3.5.

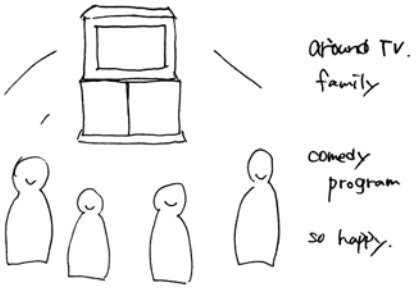
Most of the drawings created in Japan belong to the content category, while Danish drawing are more equally spread across the three categories.



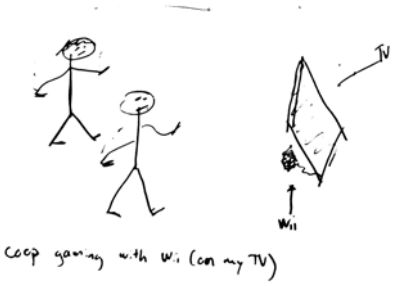
(a) *"Breaking News on 9.11.2001" Collapse World Trade Center. This news is very impressive because I [travelled to] N.Y. only 2 weeks before. I went to the roof of the building there. At my room in apartment.* (Male, 35 - Japan).

(b) *Context: at my parents home in the kitchen. Had just come back from school when I was the first plane crash into the twin towers.* (Female, 23 - Denmark).

Figure 3.4: Illustrations of TV related memories associated with television content.



(a) *Around TV. Family. Comedy program. So happy.* (Male, 24 - Japan).



(b) *Coop gaming with Wii (on my TV)* (Male, 27 - Denmark).

Figure 3.5: Illustrations of TV related memories associated with the social surroundings.

Another possible categorization of the drawings submitted consists in considering only who is depicted, notwithstanding the topic illustrated. By doing so small differences between Danish and Japanese drawings emerge. While the majority of Japanese illustrations depict the drawer alone, and to a lesser extent with family members, Danish drawings represent the drawer alone or among strangers in equal proportions.

Studying the mood expressed in the drawings on a negative-neutral-positive scale reveals other differences between the two countries. Danish drawings are mostly emotionally neutral while the Japanese ones are equally

distributed among the three emotions. This interpretation only considers the drawings within which the emotion is easily identifiable, which accounts for three fourths of all drawings. The number of sketches with unclear mood expressed is equal in both countries.

Self-depictions carrying mobile devices

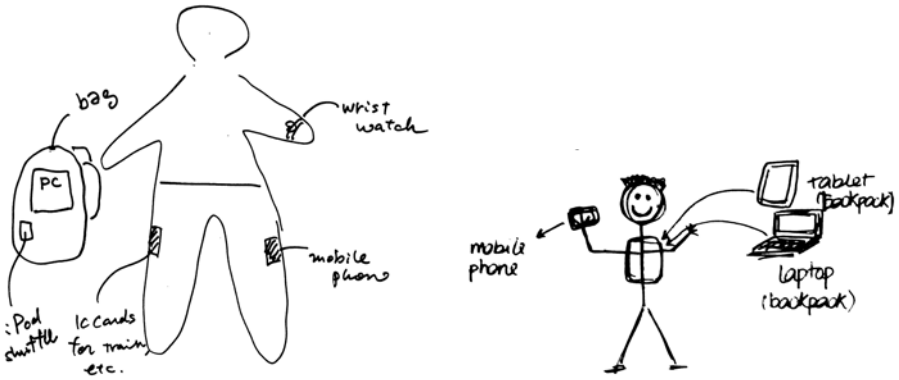
When asked to sketch themselves with the mobile devices they usually carry around, Danes and Japanese produced quite different drawings. These differences concern the number and types of devices represented in the drawings, and the place around the body where mobile phones are depicted. The analysis of the types of devices included in the drawings informs how participants understand the concept of "mobile device". In fact they were instructed to create a drawing representing themselves and the mobile devices they usually carry around, without further details about what was meant by mobile device.

Firstly, the number of devices included in the drawings is age- and gender-independent, however Japanese tend to include more devices in their drawing (2.5 devices per drawing in average) than Danes (1.8). This means either that Japanese actually carry more mobile equipment in their everyday lives, or that the mental association *mobile device = mobile phone* is stronger in Denmark, which hinders the consideration of other types of apparatuses as belonging to the category of mobile devices.

Secondly, all drawings in both countries include at least one mobile phone. This might not be surprising given the massive adoption of such device in Japan and Denmark, and considering that all participants reported owning at least one mobile phone. Still, this reinforces the established importance of mobile phones in everyday mobile lives in digital societies. Laptops were represented equally by one third of the participants from both countries. Equipment used to listen to music such as iPods were depicted in one out of four Danish drawing, while the same proportion of Japanese though about other IT equipment (including iPads and external drives). Finally, wrist watches were illustrated by one in five Japanese participants together with other non-IT equipment such as transportation cards and pens (one participant even mentioned his wedding ring), while none of the Danish participants mentioned any of such objects. Examples of self-depiction from Japan and Denmark are provided in Figure 3.6.

Personal memories about mobile phone

Similarly to television related drawings, depictions of mobile phone related memories can be categorized according to either the topic described in the picture, the social surrounding depicted, or the emotional charge of the illustration. For what concerns the topics, Danes and Japanese reported in similar proportions stories in which mobile phones have been used or misused, as illustrated in figures 3.7 and 3.8. On the one hand, "using" includes specific situations such as taking pictures, or following directions from the embedded navigation system. On the other hand, " misusing" situations reflect circum-



(a) Self-depiction including a *PC* and *iPod shuffle* in a *bag*; *IC cards for train, etc.* and a *mobile phone* in pants pockets; and a *wrist watch*. (Male, 47 - Japan).

(b) Self-depiction including a *mobile phone* in the hand; and a *tablet* and a *laptop* in a *backpack*. (Male, 22 - Denmark).

Figure 3.6: Illustrations of self-depictions with mobile devices usually carried around.

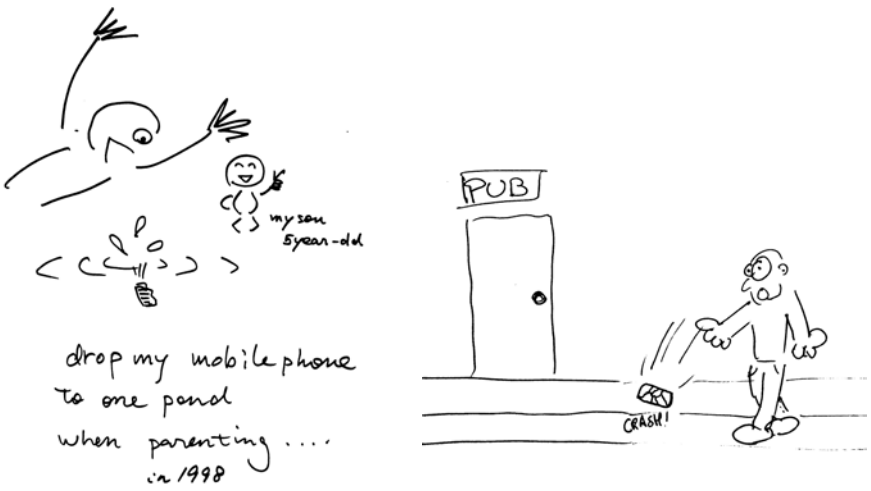
stances in which the device has been lost, broken, or subject to inappropriate handling (such as dropping the phone in water).

(a) *Google everything every time everywhere* (Male, 31 - Japan).

(b) *Capture memorable moments* (Male, 22 - Denmark).

Figure 3.7: Illustrations of memories of mobile phone use.

Common to the Danish and Japanese drawings is the social settings the memories are set up in. In both cases drawers depicted themselves alone, and only few mentioned either friends, family members, or strangers. Situations involving colleagues were sketched only by Japanese participants, while some



(a) *My son 5 year-old / drop my mobile phone to one pond when parenting... in 1998* (Male, 47 - Japan).

(b) *PUB / crash* (Male, 21 - Denmark).

Figure 3.8: Illustrations of memories in which mobile phones are misused.

Danes represented nobody in their drawing.

With regard to the emotional load carried by the drawings, the Japanese clearly focused on negative feelings, twice as much represented than positive ones, and four times more frequent than neutral ones. In Denmark however, the analysis is difficult due to the high level of ambiguity in the feelings depicted. It is not possible to conclude the emotional stance of almost half the drawings. As for the remaining half, they tend to be mostly positive oriented, slightly over neutral. Negative feelings seem very seldom.

The following paragraphs investigate the results from the second study (conducted in Japan only), a drama workshop investigating television and mobile phone experiences separately and jointly. It consisted in a sequence of four exercises: one warm-up group exercise, two individual exercises, and one group exercise leading to a group performance. The following will focus on the individual and group exercises. The warm-up exercise is discussed in Section 5.3.

Stories involving televisions and mobile phones

The first individual exercise consisted in reflecting on personal attachment with mobile phones and televisions by answering the following questions for each device:

1. How would you feel if you didn't have access to your [home television / personal keitai] any more?

To answer this question, participants had to select from a list of five faces depicting emotions (anger, sadness, neutral, surprise, and joy, as can be seen on Figure 3.9) those which would best apply to the situation.

2. List the functions of your [home television / personal keitai] that are the most important for you.

In order to do so participants were asked to write down up to three functions on dedicated paper cards (one function per card). An example of such cards generated by a participant is provided in Figure 3.9.

3. Pick among the adjective cards those that best describe your [home television / personal keitai].

Two identical sheets containing 36 adjectives (one for television and the other for keitai) were distributed to each participant, who would tick the adjectives s/he deemed best describe each device. As can be seen in Figure 3.9, the list consisted of 18 pairs of common bi-polar descriptors of objects, such as public/private, hot/cold or polite/rude.

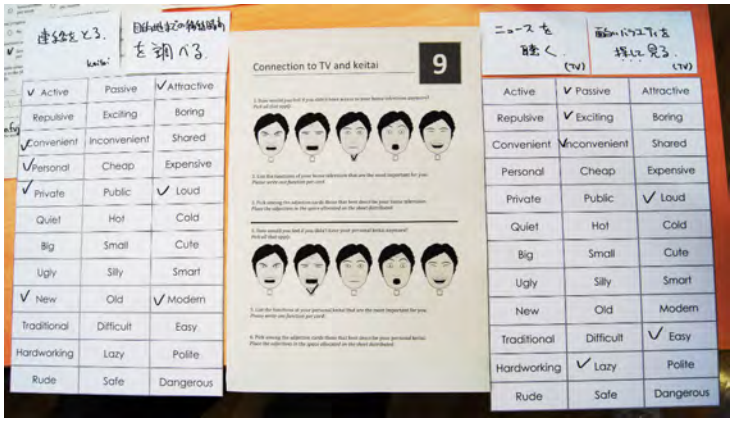


Figure 3.9: Example of participant responses for the first exercise (Male, 21).

First, the reactions to the hypothetical loss of television and mobile phone reflects different feelings toward the devices. Consistently with the results collected from the survey presented in Section 2.4, two thirds of the keitai-less respondents reported expecting to experience sadness and one in four anger, while a sudden lack of television would leave half of them with no specific reaction. In addition to these, sadness and surprise are expected to be experienced by one third and one fourth of the respondents, respectively.

The analysis of the adjectives chosen by participants to describe the two devices of interest reveals further discrepancy between the perception of mobile phones and television. The top five adjectives associated with each device (and the number of respondents who selected them) are as follows.

Television Passive (9/12), Loud (6/12), Exciting (5/12), Public (5/12), and Lazy (5/12)

Mobile phone Convenient (11/12), Personal (10/12), Private (8/12), Small (6/12), and Active (5/12)

Interestingly, the top adjectives attributed to mobile phones were selected by a larger number of respondents than the adjectives associated with television, which were more distributed among the 36 possibilities, This emphasizes the strong personal connection Japanese have with their keitai, a tie apparently stronger than with television.

Each participant also identified functions s/he considers essential for mobile phones and televisions separately. The 56 functions identified for the two devices together can be classified according to the following eight categories:

- Music or sound
- Entertainment, relaxation
- Access to information
- Communication
- Secondary function
- Design, specification
- Specific use
- Others

Table 3.2 summarizes the frequency distribution of the functions cited by participants according to these categories. TVs and mobile phones clearly serve different purposes for the respondents. On the one hand, televisions are used to access information, entertainment/relaxation, as well as for a number of specific uses (such as background sound). On the other hand, keitais fulfil a communication function, as well as secondary ones (such as alarm or calculator). The design and technical characteristics (such as network connectivity) of mobile phones also play an important functional role for participants. Overall, even within the aforementioned clusters, the functions cited are little redundant, and instead tend to cover various aspects of the same issues.

Table 3.2: Frequency distribution of important functions for TV and keitai.

Category	Television	Keitai	All
Music or sound	2	2	4
Entertainment, relaxation	6	0	6
Access to information	9	2	11
Communication	0	8	8
Secondary function	1	5	6
Design, specification	1	5	6
Specific use	2	4	6
Others	6	3	9
All	27	29	56

These functions (up to six per participant in total) were later to be used in mini-stories created from a set of context cards distributed randomly to participants. These cards contained a title and a corresponding illustration

depicting an element of everyday life situations. The complete list of elements is provided and further discussed in Section 5.3.

A problem *lost*, *forgotten keys*, *exhausted*, etc.

A location / transportation mode *kitchen*, *boat*, *street*, etc.

A social environment *colleagues*, *best friend*, *alone*, etc.

A mood *joy*, *fear*, *surprise*, etc.

Even though these elements are mundane if taken individually, dealing one of each kind randomly created unusual arrangements for participants to create stories around. The instruction given to participants was to combine these elements with the functions they had previously identified into a mini-story. They were encouraged to use as many of the functions and contextual elements as they could, although they were allowed to discard some. A few stories generated by participant are reproduced in Figure 3.10. Later, participants were grouped with two other participants and used these mini-stories as a basis for generating a coherent group story, to be eventually acted out in front of the other groups. Tracking down how the functions have been used and/or modified throughout this three-step creative process not only provides a better understanding of how important the function are for users individually and collectively, but also informs about the group dynamics during such an activity.

When creating their individual mini-stories, participants used most of the 56 functions they identified as essential, discarding only 7 of them. Three quarters of the functions kept were then used unmodified in the individual mini-stories, while the rest was modified to better fit the story. At the end of the group work however, only 11 of the original 56 functions were kept untouched, the remaining other 21 functions kept having been modified during either of the exercises. In addition to discarding 24 of the original functions over the course of the individual and collective exercises, participants added new functions during the group exercise to fit the purpose of the group story.

These observations illustrate the participant willingness to reach group consensus when merging their ideas together, which contrast with their intent to use as many as the elements they have at their disposal when creating their own personal stories. The evolution of the functions along the three steps of the creative process is illustrated in Figure 3.11 for one of the groups. Two thirds of the 32 functions that remained throughout the three activities (modified or not) are related to mobile phones and their communicative role. Access to information (mostly via television) is also recurrent in the final list of functions. This indicates the importance of these two medium specific functions for the participants. It is also noticeable that the functions seldom overlap, which denotes the separation of TV and mobile phones: the two devices are used for different purposes. Finally, the use of these functions through mini-plays acted out by the workshop participants is investigated in the next section.

(a) *Getting ready for a date.* (Male, 24).

(b) *Planning weekend activities.* (Male, 23).

(c) *Getting lost in a supermarket.* (Male, 33).

(d) *Planning a surprise event.* (Male, 21).

Figure 3.10: Examples of illustrated short stories created by four participants.

Acting out media technology

Regarding the content of the group stories to be performed as a mini-play, an evolution can be observed in the degree of surrealism between individual

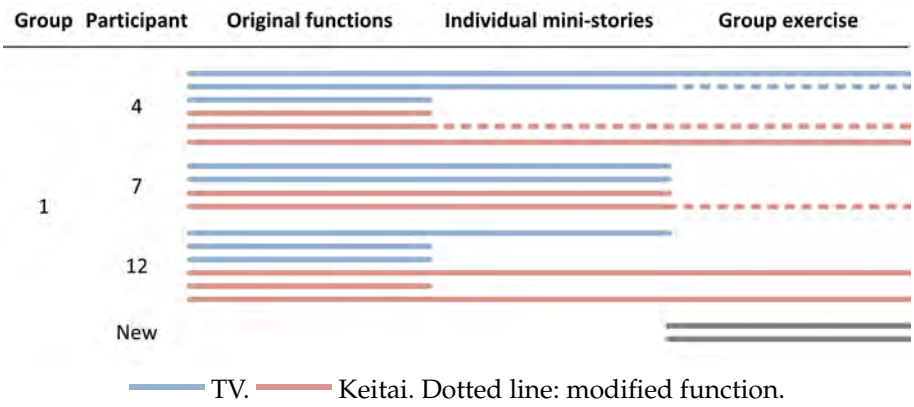


Figure 3.11: Evolution of functions generated by participants of group 1 throughout the workshop. "New" refers to the functions generated during group work.

stories and group plays. If all individual mini-stories were highly realistic in terms of environmental settings and how the technology is put into use in this environment, the group mini-plays integrate more surreal elements, especially with regard to the scene setups. Illustrating this evolution, Table 3.3 summarizes the topic of the stories created individually and collectively.

Table 3.3: Summary of topics used in the stories created individually and collectively.

Group	Part.	Individual story	Collective story
1	4	Attending a concert	A young man struggles to attend a concert that turns out to be another day
	7	Coming back home	
	12	A trip in the mountains	
2	3	A visit to the museum	An old couple orders food from an elevator stuck between two floors on the day of the March 11th 2012 earthquake
	6	Planning weekend activities	
	10	A boat trip around the world	
3	1	Taking care of a pet	An alien visits Earth on the day of the March 11th 2012 earthquake
	5	Wandering around	
	9	Planning a surprise event	
4	2	Getting ready for a date	A young man discusses his life issues with a robot cat before being reunited with his father
	8	Getting lost in a supermarket	
	11	Manage emergency situation	

More than the topic of the mini-plays themselves, it is interesting to study how mobile phones and television have been included in the plots. Table 3.4

summarizes the explicit mentions of television and keitai in the individual and collective stories. All individual short stories mentioned mobile phones explicitly, but television were sometimes mentioned only implicitly, through the functions participants identified as important beforehand. This indicates that for participants, the mobile phone as a device is important, whereas the functions of television, although important, can be detached from the physical device. Then when creating stories in groups, mobile phones were mentioned explicitly in two of the four plays, and television in one. The play from Group 4 only used the functions derived from the devices, but not the devices themselves. Extracts of the four group mini-plays are displayed in Figure 3.12.

Table 3.4: Summary of explicit references to TV and keitai.

Group	Part.	**Individual story**		**Collective story**	
		TV	Keitai	TV	Keitai
1	4	✗	✓	✗	✓
	7	✓	✓		
	12	✓	✓		
2	3	✗	✓	✗	✓
	6	✗	✓		
	10	✓	✓		
3	1	✓	✓	✓	✗
	5	✗	✓		
	9	✓	✓		
4	2	✗	✓	✗	✗
	8	✗	✓		
	11	✗	✓		

Findings summary

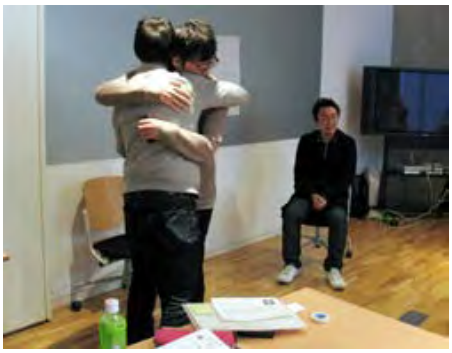
Based on the two user studies investigated in this section, the following list of findings can be established regarding the personal connections bounding Japanese and Danes with mobile phones and televisions:

- Televisions and computers are the center of the in-home media life in Japan and Denmark.
- Apart from mobile phones, Danes and Japanese alike frequently carry computers around in their everyday life.
- Memories about television in Japan are mostly associated with content; In Denmark they are also about the device itself and the social surrounding. Most memories in both countries are situations in which the author is alone. The situations depicted in Denmark are essentially emotionally neutral, while in Japan they are also positive or negative.
- Memories about mobile phones reflect situations in which Japanese and Danes are using or misusing the device, most often alone. In Japan those

(a) Group 1: *Struggles to attend a concert.*

(b) Group 2: *An old couple stuck in an elevator.*

(c) Group 3: *An alien visits Earth.*



(d) Group 4: *A young man and his life issues.*

Figure 3.12: Illustration of the four mini-plays acted out by the participants.

memories are associated with negative feelings, while the emotional load carried by Danish memories is unclear.

- Japanese deprived of mobile phones would feel greatly sad and slightly angry, while the loss of television would induce no emotional reaction or mild sadness and surprise.
- In Japan, television is used to access information and is perceived as *passive*, *loud*, *exciting*, *public*, and *lazy*; Mobile phones serve a communication purpose and are *convenient*, *personal*, *private*, *small*, and *active*.
- Japanese consider the functions of mobile phones as well as the device, whereas in the case of television the functions are more important that the device.

This section explored personal ties with mobile phones and televisions separately. In the next section, market available mobile television services allowing Danes and Norwegians to watch live television content on mobile phones will be explored from a usability and user experience points of view.

3.2 Opportunities and challenges for mobile TV

In sections 1.1 and 2.4 we have pointed out that despite its emergence and relative success in some markets, and the large attention it gained among mobile business strategists, mobile broadcast television stirs up limited interest from end users. This section addresses this ambiguity by providing insights gathered from four studies conducted within the CAMMP project. The first two studies investigated user perception and use of commercially available mobile live television services (thereafter interchangeably referred to as mobile television or mobile TV) in real settings. Results from the first study have been partially reported in Fleury et al. (2009), while the methodology employed for the second study has been presented in Pedersen et al. (2011). Sections 6.2 and 6.1 respectively provide further details concerning the methods used in those two studies. The last two studies investigated two specific issues related to mobile video: collaboration / competition (Fleury et al., 2009) and TV channel switching delays (Fleury et al., 2011b,a).

Watching television during lunch

The purpose of this activity was to investigate how users handle the consumption of rich media in a social context. Previous studies related to suitable contexts for mobile video and television consumption have been described in Section 1.1 and are not further discussed here. Nevertheless, the classification of such context established in O'Hara et al. (2007) is briefly reminded in the following, in order to contextualize the findings of the study presented below.

- Individual Viewing
  - Managing solitude
  - Disengaging from others
  - Managing transitions between spaces
- Coordinating mobile experiences with family life
  - Juggling commitments
  - Coordinating content with family
- Watching at home
- Sharing the experience
  - Watching together
  - Showing video to others
- Owning and exchanging content
- Getting content onto the devices

This first study took place in a Danish university restaurant during lunch time, and consisted in individual task-based semi-structured interviews of 26 early technology adopters (mostly males 24 years old in average with a high level of IT literacy). Since the infrastructure for mobile television was not available in Denmark at the time of the study, a local broadcasting station was set up to transcode and broadcast four live television channels to compatible receiving devices (Nokia N77 were used for the study) within the restaurant area, illustrated in Figure 3.13. In this figure the facilitator is taking note while the test participant navigate through the channels available on the service tested. The tasks to be carried out by participants were kept simple: 1) start the TV player on the mobile device, 2) surf the available channels, and 3) tune

in to the continuous news channels, watch two full reports while paying attention to the information presented in the rolling ticker at the bottom of the screen. The first task addressed two usability issues related to the mobile receive: How intuitive is it to start the mobile TV application even for first time users? How acceptable is the application loading time? The second task triggered a discussion about content available and acceptability of channel switching time. Finally the third task shifted the discussion toward the audiovisual quality of the service, and made participants focus more intensely on the content. This recreated a more realistic scenario in which the viewer is actually interested in the content and dedicate a larger amount of attention to it. The discussion that followed on the effect of the surrounding on the mobile TV experience was thus better grounded.

Figure 3.13: A university restaurant during lunch time as test environment.

Prior to the task-based activities, the test participants answered a short questionnaire about their expectations concerning potential mobile TV consumption in the future. Confirming previous findings, interviewed users reported a strong willingness to watch mobile TV in social contexts, especially outside the home in situations of static mobility (e.g. in public transports). Commuting hours and evenings (thus presumably at home) were the most envisioned time of usage. News was clearly the most cited type of content to be watched, in order not only to stay up-to-date but also to kill time. Most participants reported foreseeing to be comfortable when watching mobile TV in a public context, especially among strangers, although they would use earplugs when doing so. Furthermore, it has been repeatedly reported by test participants that the practice of watching TV in such context is similar and comparable to the practice of reading the newspaper or listening to music, which is already a common practice. For what concerns their experience with the mobile TV solution on the Nokia N77, participants reported a very positive first opinion, especially concerning the image resolution, but also with the screen size and the audio quality. The vast majority of participants could handle the application with no difficulty. When focusing on the news content, all Danish speaking participants could easily understanding the topics being discussed,

and the non-Danish speaking participants expected to be able to follow similar content in a familiar language. All participants could read the content of the ticker, and most expressed positive surprise regarding how readable the text displayed was. Complaints were however reported concerning long delays when switching channels. With regard to this issue, the delays experienced during the test lasted around 7-8 seconds, between the moment the user selected another channel and the moment the video feed of the new channel started.

Mobile television consumption in Norway

In the absence of running broadcast mobile television service in Denmark, a collaboration with Norwegian's MiniTV service granted the CAMMP project access to a pool of active mobile TV consumers. MiniTV is the product of the joint venture between the Norwegian broadcasters NRK, TV2 and MTG, offering since 2009 seven television and fourteen radio channels to mobile TV enthusiasts within the greater Oslo area on a dedicated device. The service explicitly targets five user groups: commuters (by car and public transport above ground), sailors within Oslo's fjord, sports enthusiasts (to follow specific events on the go), parents (whom children can't wait to get home to watch their programme), and families (for simultaneous watching of different programmes).

Following a survey conducted by NRK on 167 MiniTV users, a small subset of the survey participants took part in our longitudinal evaluation of the MiniTV service. From the 17 volunteers who agreed to take part in the study, 5 completed the entire study. What was originally expected to generate quantitative insight on the use of MiniTV, turned out to provide instead a brief preview thereof. When analysed jointly with the other investigations reported in this section, we find this input valuable as it not only confirms previous findings (further validating them), but also opens up for new research directions. More details concerning the methodology and a discussion of the pitfalls experienced leading to low participation and response rate are provided in Section 6.1.

The study lasted for four weeks and was accompanied by a pre-screening and a post-study questionnaires. The pre-screening questionnaire (answered by the 17 original volunteers) established that participants were advanced mobile phone users, mostly males aged 40-60 years old. Half the respondents reported sharing MiniTV with another member of the family, while the other half keep it for themselves. At home and transportation times are clearly the two most common contexts for using MiniTV. In terms of content watched, most respondents reported watching the same channels on MiniTV as on their home TV set. Half of the respondents also reported using MiniTV in front of their home television, especially when it is already occupied by another family member.

The remote survey then investigated various aspects of the participants' experience with the MiniTV service, including the context in which the service is used, the content consumed, the reasons for using the service and the

constraints faced by users while using MiniTV. The participants received two daily questions via SMS inquiring their use of MiniTV. The following summarizes the results collected during the four weeks of the study.

Context Transportation is clearly the most reported context for using MiniTV. The service is mostly used among friends, and at a low frequency of use (around a weekly basis). Some participants even reported using the service only during special (sports) events.

Content The content watched on MiniTV is mostly sport. Participants evaluated the quality of content quite poorly, with an average score of 3.8 on a scale from 1-good to 5-bad.

Reasons Participants were attracted to the service because of its technology value (they are early adopters) and the possibility to easily access content. Now they use MiniTV because of its mobility and ease of use. In terms of context they often use it to gain privacy in a public setting. Special broadcast events such as larger sports events also motivate participants to use MiniTV.

Constraints Few usage barriers were cited by participants and were related to technical issues such as bad reception, poor audio/video synchronization and stuttering of the video feed.

More general questions were tackled in the post-study questionnaire. Despite the rather poor rating of available content, respondents like using the system, especially because it brings mobility to TV consumption. Throughout the study mobility was indeed repeatedly mentioned as a key characteristic of the service. When asked to use three words to describe MiniTV, *handiness* and *availability*, together with *ease of use*, were the most popular answers. Finally, most respondents found the screen size of the device suitable, and only few considered it too small. Overall there was a good correlation between the answers collected through the survey and the pre- and post-test questionnaires.

Collaboration / competition with mobile media

The main motivation for conducting the following study comes from the lack of literature in the areas of mobile collaboration and competition. Human collaborative and competitive behaviours have been extensively studied in many contexts and from various approaches, but the available research appears to focus little on mobile settings. We considered therefore interesting to investigate firstly how users perceive these two notions put in a mobile context and secondly if these behaviours could be used to motivate user-generated content creation. Moreover, research on motivation factors for user contribution has primarily focused on online services accessed from fixed platforms. Therefore, only some of the conclusions might apply to mobile online services.

Analyses of human competitive behaviour have been carried out by many researchers, a number of whom focused on gender issues. For instance Villeval et al. (2005) investigated the differences in behaviour between women and men when choosing a payment scheme. The results show that men are more

likely to choose a competition-based payment scheme (where the highest benefits go to the best performer) than women, who are influenced by a higher degree of risk aversion. Men are also found to compete more against other men than against women. Furthermore, Rizza & Reis focused on women's competitive nature and presented a study on how competition impacts school girls in their academic and personal lives. The interviewees reported a negative perception of the term competition and preferred to use "comparison" instead. However, in this particular setting competition as such was perceived as achieving both positive or negative sociocultural results (Rizza & Reis, 2001).

When it comes to using this competitive behaviour as a motivation factor for online user contribution, von Ahn (2006) established the principles of "games with a purpose", which consists in creating games that solve computational problems that cannot be solved by electronic systems, by relying on humans to perform the task. This approach has been named "human computation" and is introduced in von Ahn (2005). To exemplify this theory, von Ahn (2006) introduces two examples of small online games based on this principle. The first game, called the "ESP Game"[1] serves the purpose of image labelling (pairs of players need to agree on labels describing an image to earn points), while the second game, "Peekaboom" addresses exhaustive image description through locating objects in pictures.

Mobile collaboration has been mostly investigated so far in the context of mLearning (Colley & Stead, 2004, Cobcroft et al., 2006). More generally the study of human collaborative behaviour can be carried out from various perspectives. For instance Semmann (2004) documents research on human cooperative behaviour in a large group of unknown individuals. Semmann demonstrates that humans naturally cooperate only under certain circumstances such as reputation building. Despite this rather negative conclusion, he demonstrated that optional participation could sometimes promote voluntary and anonymous participation. In another study, Tyler & Blader (2001) reported that the main antecedent for cooperating in a social group is the notion of identity. Maintaining a favourable image of oneself and of the group appears of primary importance and influences the group members' behaviour. Furthermore, motivational factors have been described in various setups with existing services. For instance Ames & Naaman and Nov et al. investigated the practice of tagging pictures using web-based photo sharing platforms like Flickr. While Ames & Naaman (2007) defined a taxonomy of tagging motivations along the sociality and function axes, Nov et al. (2008) report that the motivation to tag for the general public or oneself is positively correlated to the number of tags, whereas it is not the case when it comes to tagging for family and friends. Finally, Beenen et al. (2004) assesses social psychology theories as a driving tool for encouraging user participation in online communities. Reminding the contribution's uniqueness to their creator as well as assigning challenging goals seem to be an efficient way of ensuring user contribution.

[1] The ESP Game has been used by Google for its (now discontinued) *labeler* project. The game is now available at http://www.gwap.com (May 15th, 2012).

Figure 3.14: The meeting room hosting the conceptual group discussions about mobile collaboration and competition.

For the panel discussions exploring those issues in the context of mobile media, three groups of respectively three, three and five participants were formed. The sessions took place in the afternoon and lasted approximately two hours each. All participants were paid in form of cinema tickets. The test setup is illustrated in Figure 3.14. The 11 participants who took part in the discussions were mostly male, aged 25 years in average and reporting either moderate or high IT skills. Based on screening questionnaires filled out by the participants prior to the conceptual evaluation, it was established that three quarters of the participants tend to display collaborative behaviour and belong either to the group of "creators" or "critics", according to Forrester's online consumer segmentation model (Li et al., 2007a). This model, reproduced in Figure 3.15 classifies audiences according to their level of participation in generating content, from "inactives" to "creators". It could therefore be speculated that most participants in the study on collaboration and competition would be likely to contribute either with data to a platform based on user-generated content or with comments, ratings, reviews etc. to such a setup. It should however be noted that this tendency may be coupled to the relatively high IT-literacy of the panel participants.

Each panel discussion started with a brief introduction of the CAMMP project and its scope, which was followed by the illustration of the two concepts of focus (collaboration and competition) through real-world examples. A selection of scenarios were used as examples of possible concrete applications where collaboration and/or competition are involved. In these scenarios, the collaboration scheme can be interpreted either as an implicit behaviour (users collaborate with each other through the use of a service), or as a direct

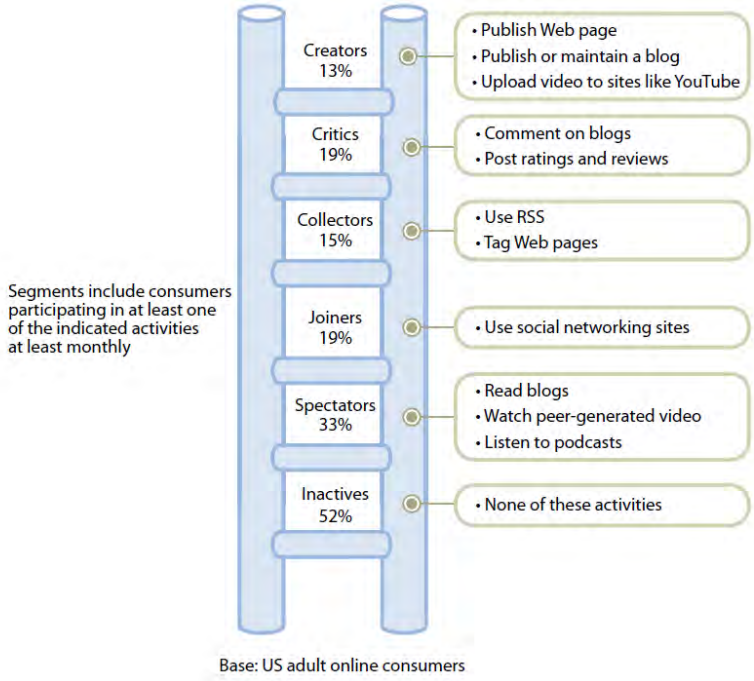


Figure 3.15: Forrester's *Social Technographics Groups Consumers By Activity In The Participation Ladder* (Li et al., 2007a, p. 5).

collaboration where users would team up prior to interacting with the service. Additionally, a realistic direct collaboration scenario was acted out by the participants themselves. The scenario required the group to identify a movie to go and watch together, from a selection of trailers that they should watch on mobile devices. Gathering the participants' input during the test session was done through notes taken by the test facilitators as well as audio/video recording.

Results

Two thirds of the interviewed users displayed, through the collaboration scenario, explicit collaborative behaviour involving verbal communication. The users reported that during such explicit collaboration involving mobile devices, issues such as omnidirectional sound and synchronization between sound and video as well as between devices could hinder user experience. The general quality of the tested handsets (Nokia N77) as well as video content broadcast via DVB-H was however praised. It was furthermore stated that while discounts or micro rewards may motivate some users to contribute with data it would potentially also open for abuse and lead to situations of untrustworthy information. It was suggested that a high level of quality in the information available may motivate users to contribute with additional data and that feedback to contributions may be highly motivating. For what concerns driving forces for competition it was indeed found that high score func-

tionalities would be important, especially when among friends. In order for users to be willing to use competitive services it was in addition argued that user settings should be centralized, which would make for instance gaming on various devices more convenient. The interoperability between all kinds of mobile terminals should also be guaranteed for the same reason.

TV channel switching delays

The channel switching delay, also referred to as tune-in time (Rezaei et al., 2007b), is the period of time from when a user selects a channel to when the video feed starts playing. As established in Fleury et al. (2011a,b), most of the literature concerning channel switching delays on mobile devices has been focusing on technical solutions for reducing such delays (see for instance the extensive work by Rezaei et al. (2007a,b), Hsu & Hefeeda (2009a,b)). Despite the number of technological improvements suggested, switching delays remain one of the critical issues with broadcast mobile television (Buchinger et al., 2009). A general consensus on "the shorter the delay the better the experience" has led to few studies addressing the issue from the end users' perspective. A review of these few user studies are described in the following, while Table 3.5 summarizes and extends the findings presented in Fleury et al. (2011a).

Investigating end user acceptability of waiting times on mobile devices, Niida et al. (2010) quantitatively compared delays associated with several common activities: accessing a website, placing a voice call, sending an email without and with an attachment, and downloading a file. The results from the experiment classify these activities into two groups, reflecting user expectation toward system response time. The three first activities are expected to generate little delay, while the last two studies are expected to be associated with longer waiting time. The difference between the two groups regarding what participants deemed acceptable in terms of delay (the mean opinion score (MOS) being 3 on a 1-5 scale) varied by five seconds, from 6 to 11. When it comes to mobile television, it is generally accepted that people dislike waiting for the channel requested by the user to start playing (Cui et al., 2007). However Knoche & McCarthy (2005) notes that switching delays between two channels are commonly as high as 15 seconds, which is incompatible with the expected hopping behaviour of mobile television users. Similarly a comparative study of DVB-H and 3G reported DVB-H related switching delays between 3-39 seconds (with 5.2 seconds in average), compared to 9-57 seconds (19.7 average) in 3G. Finally, Robitza et al. (2010) measured DVB-H induced channel switching delays to range between 4.5 and 15 seconds, and 7.4 seconds in average. The study also shows that subjective perception of waiting time is uncorrelated with actual waiting time. Study participants felt that they were waiting less than they actually did. Focusing on IPTV but methodologically close the the study presented in this section, Kooij et al. (2006) established a model relating MOS to television channel switching time.

As can be seen in Table 3.5, the range of delays observed with existing mobile broadcast television systems varies greatly, and little reflect the technical implementations proposed to reduced such delay. In addition, the observed

Table 3.5: Summary of acceptable channel switching delay studies.

Source	Study type	Maximum delay (application)
Nielsen (1994b)	Recommendation	< 1 s (interactive systems)
Bae et al. (2007)	Recommendation	< 2 s (IPTV)
Rezaei et al. (2007a)	Technical	0.9 to 1.6 s (DVB-H)
Rezaei et al. (2007b)	Technical	Close to 0 s (DVB-H decoder refresh time component) From 0.5 s to a few seconds (tune-in time due to decoder refresh)
Hsu & Hefeeda (2009a)	Technical	500 ms (DVB-H)
Hsu & Hefeeda (2009b)	Technical	200 ms (DVB-H)
Knoche & McCarthy (2005)	User (observed)	5 to 15 s (SDMB)
Cui et al. (2007)	User (observed)	Up to 10 s (SDMB)
Grivet (2009)	User (observed)	3 to 39 s, average 5.2 s (DVB-H) 9 to 57 s, average 18.7 s (3G)
Kooij et al. (2006)	User (acceptable)	0.43 s (IPTV)

delays remain above recommended waiting times for such systems. Despite its high relevance to the present work, the studies in Niida et al. (2010, 2011) are not reported in the table, as they are not specifically targeted at mobile media systems. The study presented in Fleury et al. (2011a,b) aimed at identifying the threshold above which the waiting time is perceived as annoying. Similar to the experiment in Robitza et al. (2010), test participants navigated freely through a playlist of video clips, pre-padded with delays of varying duration (linear range from 0 to 10 seconds with 1 second steps). The range of delays was inspired by response times from existing systems, from analogue TV (virtually instantaneous switch) to current mobile broadcast TV (up to 10 seconds or more). The delays were presented randomly to participants and experienced three times each. The participant playlists thus contained 33 video clips, the content of which had been randomly recorded from TV channels before the experiment. As a conclusion to this experiment, participants judged annoying delays superior to 5.7 seconds.

Observations from Kooij et al. (2006), Niida et al. (2010) and Fleury et al. (2011b) are depicted in Figure 3.16. According to the figure, it seems that the MOS response distribution follows the distribution of the waiting times experienced by test participants. Indeed, Kooij et al. (2006) selected a range of waiting times following a logarithmic distribution and observed a logarithmic distribution of MOS, while Fleury et al. (2011b) adopted linear scales and observed linear responses. The case of Niida et al. (2010) falls somehow in-between, as the range of delays selected was partly linear and partly logarithmic, while the MOS response distribution is logarithmic.

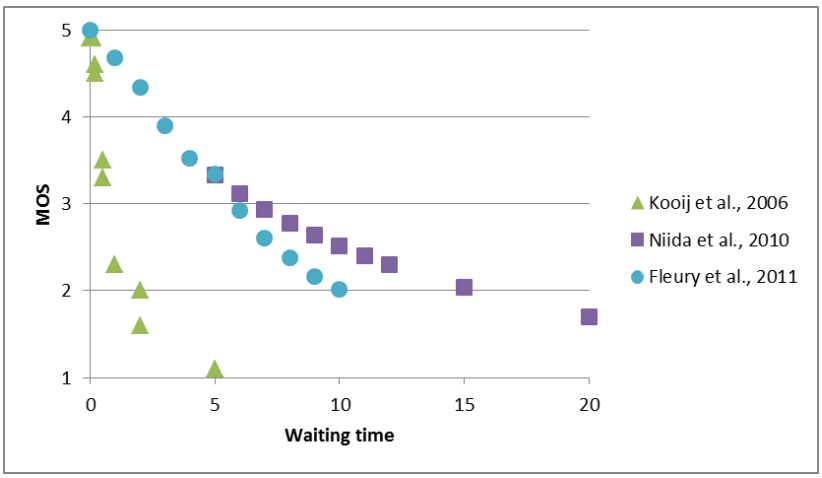
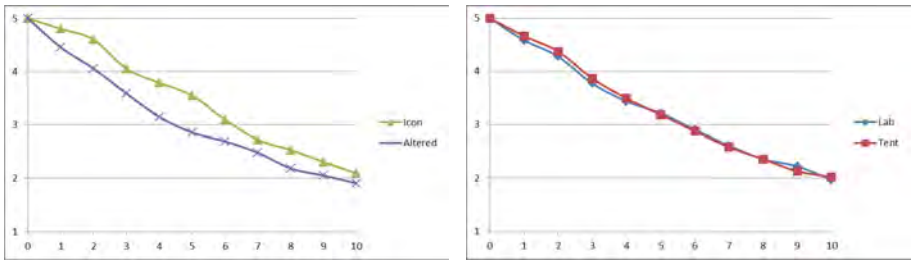


Figure 3.16: MOS response to waiting times across three studies.

Factors influencing perceived user experience

A number of parameters can arguably influence acceptability perception of switching delays. For instance Godana et al. (2009) found that displaying random advertisement pictures improved perceived quality of experience (QoE) for waiting times above 0.65 seconds in IPTV systems. Similarly, De Wachter et al. (2007) argue that displaying a low quality version of the channel to be switched to not only decreases the perceived waiting time, but is also a technical solution for reducing the actual delay. In addition to those studies, Kooij & Geijer (2012) studied how playing small games while waiting for channel switches in IPTV systems affects QoE, compared to being presented with a black screen. The authors found that games are preferred over the black screen for delays above 2.25 seconds. MOS of 3.5 is obtained either with black screens for delays under 1 second, or with games for delays above 3 seconds. The type of transition have been also argued to influence perceived quality of experience. To demonstrate this, Robitza et al. (2010) tested four types of transitions: a black screen, an animation including the message "Please wait...", a random brand logo, and a random short commercial video clip, played entirely. The latter appeared to be the most acceptable transition between content, the logo being a good alternative. In another set of experiments, Niida et al. (2011) investigated five "time fillers" displayed while sending an email from a mobile terminal: a loading bar, discrete or continuous progress bars, a loading bar with a trivia, and a continuous progress bar with trivia. Results from the quantitative experiment shows that displaying a continuous progress bar significantly reduces dissatisfaction with waiting time. Additionally, trivia further decrease dissatisfaction, but only for longer delays and if the trivia's topic interests the viewer. Finally, Niida et al. (2010) hypothesised that the environment and level of stress impact the perceived QoE when waiting for mobile systems to respond. Results from their experiment however are inconclusive in that regard.

In Fleury et al. (2011a,b), three factors were tested for their impact on the perceived acceptability of transition time between two channels on a mobile device: the type of transition, the test environment, and the type of audiovisual content. With regard to the transition type, the animated icon used while videos are loading on YouTube was compared to a combination of degraded video and clear audio. The transition delays were experienced either in a quiet laboratory or a usability tent, inside which bus trip was simulated via audiovisual stimuli. Finally, the content types were categorised according to a modified version of the LSCOM-Lite content classification scheme (Naphade et al., 2005) and included news, entertainment, and various shot types such as indoor or outdoor, and displaying either a single person or a group of people.



(a) Transitions type. (b) Test environment.

Figure 3.17: Effect of transition type and test environment on acceptability of transition delays.

As depicted in Figure 3.17, results show that delays visualized with the icon are found significantly more acceptable than those visualized with the altered content. On the contrary, the test environment was found to have no significant effect on the acceptability of switching delays expressed by participants. Similarly, preliminary results from the analysis of the content type also showed no significant effect.

Conclusions regarding mobile TV

From the various user studies reported in the previous sections, a number of opportunities and challenges regarding mobile television can be drawn, complementing previous findings available in the literature. As detailed in the following, these findings are related to context of use, content, motivations, and technical challenges.

Contexts of use

As stated in O'Hara et al. (2007) and Trefzger (2005) users have very different needs regarding mobile TV content and interaction when on the move than when watching TV at home. These studies emphasize that mobile TV is principally consumed outside the home environment to manage solitude, disengage from others, manage transition between places or juggle commitments. It also appears that people tend to use mobile TV services at home, in

order to coordinate TV content with the family or simply to combine TV consumption with other factors such as devices sharing or need for togetherness. These tendencies have been only partly confirmed in the first studies reported here, which identified commuting time as the main context for mobile TV consumption expected in Denmark and observed in Norway. Workplace and home to a much lesser extent were also found important. Concerning time if use, no clear peak time has been previously identified to dominate mobile TV consumption, which is mostly spread across the day and tightly related to the user activities (Schuurman et al., 2009). Confirming this trend, no clear mobile TV time emerged from the studies reported in the previous paragraphs. Instead, mobile TV consumption is dependent on current activity, and the perceived meaning of the place the activity takes place in. As argued in Harper et al. (2007), places with no value can actually give value to mobile TV, and mobile TV has the potential to enhance ongoing experiences, for instance by granting access to additional content during sport events attended live. Additionally Harper et al. stated that the experience and affordance (as defined in Norman (2002)) of technology matter more than the technology itself. That is, the experience lived while watching mobile TV is more important than what is watched. This was seen in the Norwegian study, where participants unanimously liked the MiniTV service despite considering poor the quality of content available. Finally, the practice of "trafficking" (sharing video segments from mobile to mobile) appears to be a new way of binding people. Harper et al. consider trafficking as a new genre of content, which combines illegally downloaded, bought for, and self-created content. This topic was only briefly addressed by participants of the conceptual study on mobile collaboration. It appeared cleared though, and this will be further discussed in sections 3.3 and 3.4, that synchronization between devices and facilitating easy transfer of content across them is a prerequisite for service success.

Content

Despite the general agreement that content is one of the foremost factors capable of driving adoption of mobile television (Buchinger et al., 2009), interesting content seems to lack in current TV offerings even in countries such as South Korea where adoption is high (Cui et al., 2007). Reviewing a number of study reports, Schuurman et al. identified three types of content relevant for mobile TV and desired by end viewers: 1) linear transmission offering a "second TV" experience, 2) repurposed content, that is reformatted linear content (shortened, cropped, stabilized), and 3) mobile specific content (Schuurman et al., 2009, 2010). Regarding existing genres, the study found that news, soaps (including series) and sport, forms the "content triumvirate" of mobile television offer. News and sports indeed appeared favoured by Danes and Norwegians in the studies conducted in theses countries. As evoked in Section 2.4, news and entertaining content are also leading genres in regular, fixed television viewing habits. This confirms early findings that mobile TV users expect to be able to follow the same content available on regular TV on their mobile devices (Södergård, 2003). Additional genres potentially important in supporting adoption but not discussed in studies reported in this dissertation include music videos, films (during long travels), and adult content. Content consumption however seems tied to context and activity (Oksman

et al., 2007), and as also suggested by the MiniTV user trials. Finally, the social dimension of mobile TV and the need for personalized content appeared in another early experiment with DVB-H mobile TV Denmark in the context of the CAMMP project (Sørensen & Nicolajsen, 2010). A number of ideas for specific services were generated by potential early adopters of the technology, including games, video-on-demand, and information retrieval systems.

Motivations

Not surprisingly, staying up-to-date and killing time with entertainment are the main drivers of mobile TV consumption, which corresponds to the content desired by audiences discussed in the previous paragraphs. Schuurman et al. (2009) identifies two additional purposes for mobile television: as a background while performing other tasks, media related or not, and as a second TV, when the primary set is occupied or when there is a conflict related to the content to be watched. Additional motivations for adoption and use include high image quality with format adapted to mobile screens, adapted content (such as on-demand news of looped programmes of short duration), wide coverage and low cost (Carlsson & Walden, 2007). When it comes to the social aspect of the service, being able to exchange content among peers and contributing to online communities with user generated content can be encouraged by ensuring the quality of content available, which according to our study participants would not only stimulate participation but also increase the quality of content contributed with. This behaviour can be seen in existing services such as YouTube. Much of the content available is posted by individuals, yet the most viewed, liked and discussed videos are professionally edited (Kruitbosch & Nack, 2008). As a result, more and more videos posted on YouTube are of much higher quality than originally at the start of the service, and the number of contributions steadily increases over time. Another typical example illustrating this behaviour is Wikipedia. The sole purpose of the service is to provide high quality content, which encourages contribution from thousands of individuals. As the content increases in size and quality, more contributors join in the project. It should be noted however that in some cases these mechanisms are limited in time. If YouTube seems to enjoy a continuously exponential growth in amount of content it hosts (Cheng et al., 2008), in the case of Wikipedia the exponential growth of contribution observed in the first five years of the service has been followed by a plateauing phase and is now regressing (Almeida et al., 2007, Ortega, 2009, Suh et al., 2009)[2]. Based on the promising results from studies concerned with mobile UGC such as Sørensen & Nicolajsen (2010) and the similarity of YouTube behaviour on PCs and mobile devices (Finamore et al., 2011), UGC-based mobile TV services seem to be up for a successful future.

Challenges

The potential success of mobile television is of course subject to a number of challenges that remain to be addressed. In the early days of mobile TV-related field trials, some researchers focused their studies on imaging issues

[2]See also Wikipedia's own article about *Modelling Wikipedia's growth*: http://en.wikipedia.org/wiki/Wikipedia:Modelling_Wikipedia's_growth (May 17th, 2012)

related to the use of a small screen. For instance, Knoche et al. (2005) and Knoche & McCarthy (2005) identified requirements for mobile TV interfaces with regards to image resolution, bandwidth and user interaction. The main issue in terms of image resolution concerned the level of details offered to users, especially with textual information associated with a very popular content like news. Depending on the content played, a smaller resolution does not automatically result in a worse user experience. Although users clearly ask for the highest image quality possible, these studies demonstrated that they tend to accept more easily low bandwidth when associated with a small resolution. These technical limitations have been overcome since, thanks to increased performance of mobile terminals, higher screen resolutions, and increased network bandwidth capacity. In countries with high ICT penetration, it is now possible to enjoy full HD videos (that is, with 1080 pixels of vertical resolution) on an increasing number of smartphones and tablets. One critical issue with desired mobile TV content like news is the readability of textual information, such as scrolling tickers.

In addition to appropriate content, which was discussed previously, Cui et al. (2007) identified two main barriers to potentially wide mobile TV adoption: battery life and device size. Concerning the latter, the past few years have seen an increase in popularity of smartphones sporting large screens (above 3" in diagonal), and the apparition of tablet computers, offering 7-10" diagonal size screens, which contrasts with earlier smaller models. Not only this tendency provides end users with increased screen real estate and thus higher usability, it also allows manufacturers to embed more equipment into their device cases, including bigger batteries. Battery life has become a critical parameter of device assessment, as the integration of more functions into single all-purposes devices requires more powerful processing power (Mayo & Ranganathan, 2005, Carroll & Heiser, 2010, Rice & Hay, 2010), which is especially true with popular services such as YouTube accessed over 3G networks (Xiao et al., 2008). This higher energy demand and the increasing numbers of antennas embedded in mobile devices can drain batteries in a short matter of time. Additionally, it seems that power consumption of modern devices increases at a higher rate than batteries increase their efficiency and power storage capacities.

Price, video quality, programme content, device quality, and ease of use are the critical adoption factors identified in Shim et al. (2006); among which price and usability are still to be discussed in this short review. Concerning prices, previous literature reviews have failed to pinpoint which of a flat fee, pay-per-view, advertisement-based or a combination of those schemes would best suit mobile TV's uncertain business model. When asked about how much potential users are willing to pay for the service, answers vary from study to study but remain constant concerning one aspect: people are not willing to pay much for accessing television on their mobile phones (Buchinger et al., 2009). Another aspect on which studies converge is on the usability of the service. Access to mobile TV should support its most demanding use scenario, in which people get the device out of their pocket for a short break during which they wish to access a specific kind of content. Access to mobile TV services should thus be fast and interruptible, so users can quickly hop in and out,

and it should allow them to efficiently browse through a catalogue of content available for easy access to desired material. Concerning the interaction with a software interface, study participants in Knoche et al.'s experiments recurrently wished for being able to access TV guides, to suspend the content played, and to have access to as live content as possible (Knoche et al., 2007). Those expressed needs must be turned into design requirements in order to ensure high user experience for future mobile TV services.

In conclusion, mobile TV should offer a personalized and interactive user experience, adapted to fast paced mobile lifestyles and that support ubiquitous viewing (Cagenius et al., 2006, Cui et al., 2007). In particular, the integration of mobile television in the everyday media landscapes requires a great degree of synchronization and interactivity between the various media devices available at home, at work and on the move. The remaining sections of this chapter will thus take a step back from mobile TV and consider challenges related to other aspects of the television / mobile convergence. Specifically, the next section will address how mobile devices can support and enhance the TV experience in the living room.

3.3 Feasibility of second screens

As glimpsed in the previous section, the integration of television and mobile technologies is becoming a reality in today's home media environments. Here the concept of second screen is introduced and discussed through the lenses of a series of workshops aimed at exploring if test participants liked to interact with TV content through a secondary device and which kinds of interaction types they preferred with which content. The work reported in this section has been partially published in Fleury et al. (2012a).

Status on second screens

Television-related technologies have evolved vastly lately, and so as evolved TV consumption habits (Cesar et al., 2010). On the one hand TV is changing its form, with the consumer moving from passive reception of one way broadcasts to being a part of an interactive media experience. The TV audience is starting to get used to having a much larger degree of control over the TV content. On the other hand, TV remains a social experience, yet the changes occurring at the interactivity level are intertwined with the social aspect of TV (Cesar et al., 2008b). This evolution of television has also been established in Tsekleves et al. (2009, 2011): television is the dominant entertainment medium in the home for it allows relaxation and it is familiar and easy to use. In addition it is a shared resource and is associated with social interactions. A first observed converging media practice appeared between television and Internet. According to Hess et al., "*TV and Internet are interwoven in their usage, especially for (1) searching for information, (2) staying in contact with friends or colleagues and (3) the selection of devices for media consumption*"(Hess et al., 2011, p. 15).

At the same time, smart phones and tablets are making their way into the home. As a result more TV viewers engage in media multitasking activities such as browsing the web while watching TV: In Denmark, 48% of people above 15 years old report browsing the web on a smartphone of tablet at least weekly while watching TV, and 45% of those focus on their Internet activity when doing so (Larsen & Svenningsen, 2011). This tendency was confirmed in Section 2.4, which revealed that about 50% of Danes and Japanese surveyed affirmed using other media devices while watching TV often, and 40% additional sometimes. Similarly in the US, Nielsen reported in 2011 that *40% of tablet and smartphone owners use them while watching TV*[3]. Therefore and according to Tsekleves et al., second screens are positively welcomed for sharing photos, TV shows, other videos, and films. Similarly, TVs would be used to share TV shows, photos, films, and other videos. Today broadcasters are striving to support this evolution and provide cross-platform solutions to deliver content to their audience, as it is the case with BBC's iPlayer in the UK (Thompson, 2010) and ARD and ZDF's Mediathek portals in Germany

[3] 40% of tablet and smartphone owners use them while watching TV: http://blog.nielsen.com/nielsenwire/online_mobile/40-of-tablet-and-smartphone-owners-use-them-while-watching-tv/ (May 14th, 2012).

(Berthold et al., 2010). Similarly in Denmark, the platform DR Nu[4] allows media consumers to watch past programmes on computers and mobile devices. Communication between content providers and end viewers increasingly becomes two-way instead of one way. From a research perspective, it is therefore interesting to investigate how to successfully combine television and mobile technologies in a cross media, or second screen environment. As a first step it is essential to find out what types of interaction TV consumers would like to engage in through a second screen application and how this should be designed.

Second screens have been on the agenda of interactive TV researchers since the mid-1990s, focusing on various aspects of the integration of the two devices. A number of prototypes have been designed and tested with potential end users, ranging from multimedia content manipulation for real estate agents (Robertson et al., 1996) to content augmentation for language learning (Fallahkhair et al., 2004). However prior to pushing such innovative products to the market, one needs to investigate if viewers actually want to have the opportunity to interact while watching a TV show, and if this provides added value to the TV experience. Such an experiment was recently conducted with eleven households, and reported in Basapur et al. (2011). In this study the families were provided with a second screen prototype with which they were to interact while watching various TV shows for a period of three weeks. The qualitative data collected put forward twelve main topics of discussion, including general comments, liked features and issues. The enhancement of TV experience was found to be due to two factors: 1) the possibility of accessing extra relevant information immediately and after the show, and 2) the broadening of the experience to outside the TV room and to an extended social circle. Synchronization and relevance of content, variety in information sources, filtering of user generated content, and personalization of information were other characteristics found necessary to ensure the success of such service.

Recently, the extensive work by Cesar et al. on the concept of secondary screen illustrates the diversity of possibilities offered by multi-device media environments by exploring new interaction paradigms (Cesar et al., 2008a). According to the authors, the possibility to bring media content along on a mobile device when leaving the home TV set has been mainly investigated through a technological perspective, disregarding user studies. Cesar et al. introduce a taxonomy describing user behaviours in multi-devices media environment. The taxonomy includes content control (deciding what and how to consume TV content), content authoring (actively manipulating the TV content), and content sharing (socially communicating with others). Relevant to our study is the concept of 'presentation continuity' under the control activity, which allows users to bring their media content along on their mobile device when leaving the room in which the fixed TV set resides. This concept will be covered in Section 3.4 of this dissertation, via the investigation of four specific methods for transferring video content from a mobile phone to a TV set in a

[4]DR Nu: http://www.dr.dk/nu (May 14th, 2012).

ubiquitous home media environment. The remaining three concepts of controlling, enriching and sharing content are discussed in the present section.

Second screen prototypes

The series of workshops conducted in the context of this dissertation has been designed for investigating not only acceptability of second screens from a conceptual point of view, but also two more specific issues inherent to interactive television services: prompting strategies, and separation or combination of content and interactive functions. On the one hand, prompting strategies address the issue of engaging viewers in using the interactive service relevant to the TV show currently watched. For instance, assuming a quiz game show offers its audience the possibility to play along live participants, how to grasp viewers' attention toward the second screen where the interaction takes place? On the second hand, content / interaction separation refers to the distribution (merging or splitting) of the live TV stream and interactive elements between the primary and secondary devices. In order to explore those issues, we invited 23 Danish media consumers between 18 and 60 years old to try prototypes and engage in card-sorting like activities, in four groups of 5-6 people. The prototypes, depicted in Figure 3.18 illustrate interaction schemes associated with four genres of TV shows: 1) a news show (*TV Avisen*, a national news bulletin), 2) a consumer show (*So Ein Ding*, which reviews new technology products), 3) a talk show (*Aftenshowet*, in which a couple of hosts discuss news related topics with guests), and 4) a quiz show (*Hvem Vil Være Millionær?*, Danish version of *Who Wants to Be a Millionaire?*). Table 3.6 presents the types of interaction associated with each of these shows.

Table 3.6: The four TV shows and associated interaction schemes.

TV show	Interaction type
TV Avisen	Retrieve more information about the news items presented. The extra information retrieved is displayed on the second screen.
So Ein Ding	Participate in poll (like/dislike) about a product being reviewed. Results from the poll are displayed on the primary screen, as an overlay to the live video feed.
Aftenshowet	Submit comments related to the programme. The comments are displayed in a ticker rolling at the bottom of the live video feed on the primary screen.
Hvem Vil Være Millionær?	Answer questions simultaneously with live participants. Answers (correct/incorrect) are displayed on the secondary screen.

The tasks performed by workshop participants with the prototypes consisted in engaging with the interactive activities described in Table 3.6 while an extract of the corresponding TV show was played on the wall-mounted TV screen. In addition to the four basic scenarios, the *Aftenshowet* and *Hvem Vil Være Millionær?* prototypes have been modified to address specifically the issues of prompting strategies and content / interaction separation. Participants

(a) TV Avisen. (b) So Ein Ding.

(c) Aftenshowet. (d) Hvem Vil Være Millionær?

Figure 3.18: Prototypes of interactive second screen services designed for the workshop.

experienced different prompting strategies through the *Aftenshowet* prototype, while *Hvem Vil Være Millionære?* illustrated two variations of the game where content and interactivity are either separated or combined on the secondary screen.

Prompting strategies The first prompting method investigated occurs on the primary screen by way of a ticker message encouraging viewers to send comments via the app running on the secondary device. The second method occurred on the secondary screen, via a message popping up while the user is using the app. In both cases the task scenario required participants to be using the app when the prompting occurred. This helped not only keeping the test conditions similar, but also illustrating an issue inherent to prompting on secondary devices: how to draw the attention of viewers toward the secondary device when it is not already in use.

Content / interaction separation To illustrate how interactivity and content can remain separated, the interactive content (that is the questions to the quiz show and the clickable options to cast answers) are displayed on the secondary device while the live TV show plays on the TV screen. To illustrate a case where those two are combined, both the interactive content and the live video feed are displayed on the secondary device, in sync with the TV video feed.

Workshop participants

The prototypes developed were tested by two populations. In the first two workshops (W1 and W2), 5 males and 6 females between 38-58 years old were recruited from the "DR panel", which consists of approximately 7000 voluntary Danish citizens above 15 years of age. Comparatively, 6 males and 6 females students from Aalborg University in their early 20s were equally distributed among the last two workshops (W3 and W4). All 23 participants are active media consumers and demonstrated a medium to high level of IT literacy.

Results

The four workshops generated 813 statements from the 23 participants trying out the prototypes and engaging in discussions following a semi-structured interview approach. The statements were systematically classified according to five categories: 1) overall user experience (9% of all comments), 2) interaction and content (42%), 3) prompting strategies (9%), 4) user-generated content (19%), and 5) usability and practical issues (18%). As illustrated by the percentages in parentheses, the number of statements were unequally distributed among the five categories. Figure 3.19 further illustrates this discrepancy and the distribution of statements produced during each workshop. As can be seen, all groups discussed mostly issues related to interaction and content. Additionally, participants from both age groups generated an comparable number of statements (400 and 413). Workshops 1 and 3 generated slightly more statements (252 and 222, respectively) than W2 and W4 (148 and 191).

This somehow lower productivity can be explained by the fatigue level of participants in W2 and W4, which took place later during the day (15:00 to 17:00) compared to W1 and W3 (12:30 to 14:30). The following paragraphs summarizes the main trends identified within each statement category.

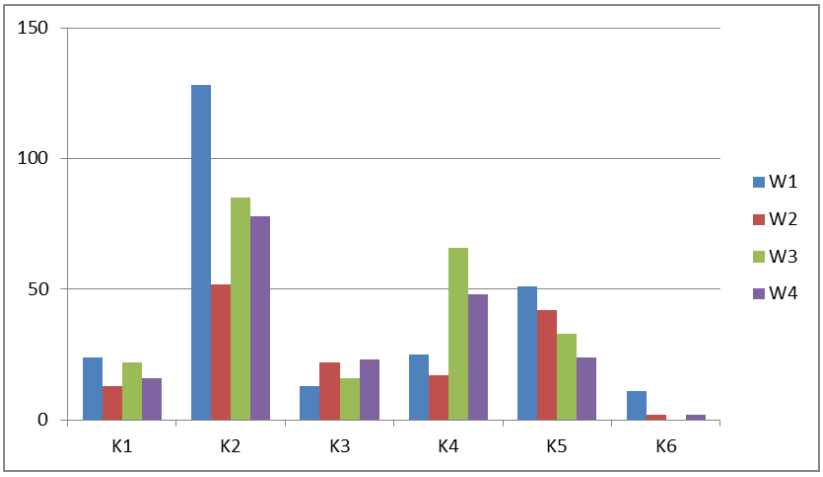


Figure 3.19: Frequency distribution of comments across categories (Kx) and workshops (Wx).

Overall user experience

Participants showed interest in the interactive features they experienced during the workshop and expect such innovations to be part of the future television experience, under the condition that they are easy to access and use. Some older participants however felt that they were not the main target audience for such features. Critics were emitted toward the possibility of disrupting the TV experience, by removing its relaxing property or shifting the viewers' focus away from the broadcast content. Participation should be left up to the audience, who should thus be able to switch on and off the interactive services as desired. General interaction between audience and broadcasters was also discussed: some programmes (such as talk shows) are suitable for submitting user-generated content, while others (such as news programmes) are seen as "receive-only" programmes.

Interaction and content

Participants from all workshops stressed that certain interaction types are only relevant to certain programmes, for instance voting for quiz shows. In general entertaining programmes are better suited for interaction than informative ones. The possibility to access more information about the current programme and to bookmark a programme for later revision or as a reminder to further explore are clearly seen as useful features. Uploading user-generated content and sending comments/questions to the programme editors also generated interest. This requires 1) the user generated content to

match quality requirements, and 2) a dialogue with the editors is established, instead of using the feature as a mere feedback channel.

Discussions about having the TV show running on the secondary device generated much debate. Participants clearly agreed that the TV content belongs on the primary screen and interactive content and controls on the secondary device. Furthermore having both content and control on the secondary device may render the primary screen irrelevant, as one participant said: "When having the content along with the controls on the secondary screen the primary screen becomes unnecessary". In other words, this corresponds to just watching mobile TV.

Nevertheless, watching TV shows on the secondary device is considered convenient under certain circumstances, such as when leaving the room where the primary screen resides without missing out on the TV experience or when the primary screen is occupied by other viewers watching a conflicting program: "I would prefer to watch content on the primary screen, but would also like to have the opportunity to watch it on the secondary screen for situations where there is no primary screen available". The participants wanted to be able to control if the show should be running on the secondary device, in sync with the content broadcast on the TV screen.

Prompting strategies

Participant agreed that they need direct solicitation for using the interactive services available on the second screen, as this is not yet a common practice. At first, almost all participants agreed that prompting should not happen on the primary screen. One said: "It is annoying to look at prompting on the primary TV screen, and an advantage of being prompted on the secondary is that users have the control and can choose for themselves if they want to look at prompting or not". However, participants also wondered how one would be made aware of the opportunity to interact with a TV show: "I would prefer that the prompting occurred on the primary screen as I don't want to sit with my secondary device all the time waiting for this to happen". Discreet prompting solutions such as a soft sound, an icon in the corner of the TV screen, slightly animating the channel logo, or specific timings (before programmes or during breaks) were suggested.

Moreover, participants generally agreed that the second screen setup does not render the primary screen superfluous, even though some admitted that "I did not look up at the TV at any time, while interacting and watching the TV show on the secondary device". This ambiguity is clearly due to the fact that TV consists of both audio and video, and in many cases the audio is quite sufficient for viewers to continue following a TV show even when engaged in other activities, for instance on a second screen. This is expected to be especially true with low engagement TV shows such as entertainment or sport, which are particularly suited for second screen services.

User-generated content

This topic was the most discussed one in the third workshop, and generated diverging opinions in all groups. All however agreed on the need to make access to user-generated content optional. UGC should also be clearly indicated as such, moderated (even though who should do it is unclear), possibly edited (to keep the broadcast professional looking), and dissociated from personal identifiers (although contributors should be held responsible for their submission). As previously discussed, content submitted should be acknowledged by programme editors to encourage further participation. Risks related to spam, hidden advertising, and censorship were also recurrently mentioned. These issues are perceived less critical if the content is available on the secondary device, which leaves us to believe that people consider content displayed on primary (TV) screens as more authoritative, and requiring less critical thinking.

Usability and practical issues

All groups confirmed that interactive features should be optional or filtered, and that it should be easy to access and use. The content on the primary screen should be kept minimal and uncluttered. The ticker was much debated in the second workshop, but no clear agreement on whether its presence on the primary screen is useful or disturbing was reached. Keeping broadcast content and interactive features separated appears sensible when sitting in front of the primary screen, however it should also be possible to access them both on the secondary device when leaving the primary screen. Especially with quiz shows, using only the secondary screen made sense to most participants. Moreover, they suggested binding all interactive functions into a single application, regardless of the channel, programme, or type of interaction to be accessed, and to offer a Twitter-inspired feed of extra information available running on the secondary screen as design proposals.

Additional statements about long lasting battery time, big screen size, fast system response, and general ease of use were coherent with previous findings concerning second screens (Basapur et al., 2011), mobile TV (Knoche & Sasse, 2007), and general usability principles (Nielsen, 1994b).

Social context

In workshops 3 and 4, the social context took an important part of the discussions. It is expected to drive viewers' desire to engage with interactive features. According to the participants, primary interaction (happing face-to-face between co-viewers) would take precedence over mediated interaction, except when all can engage in for instance a quiz show.

Findings summary

This section presented results from a series of workshops investigating second screen use for TV. Overall the interactive features were well received, although some programmes are considered more suitable than others for supporting interaction. Audiences are not yet used to interact with TV shows through

secondary screens and thus require to be prompted when interactive features are available. Such prompting should be very discreetly advertised on the primary screen, in order to only redirect potentially interested users toward the secondary device. This discussion puts forward an ambiguity inherent to the second screen paradigm: How to involve viewers in a secondary activity that takes away their attention from the primary screen while keeping their focus on the broadcast program? Similarly, study participants demonstrated little interest in mixing live TV content and interactive functionalities on the secondary screen, unless in specific situations. The primary screen can be used to display collaborative contributions such as poll results, but not personal opinions. The TV receiver is thus mostly dedicated to content playback, while value adding interactive services belong to the second screen.

On a side note, the workshops revealed discrepancies concerning how individuals perceive TV audiences: some believe that television consumers are critical and capable of making sense of what is reliable and criticize what is not; while others expressed their concern about audiences potentially being either flooded with debilitating content or otherwise manipulated through inappropriate censorship. These issues have been widely discussed by mass media scholars although we believe they require further attention within transmedia contexts. Indeed the increasing amount of information available via second screen services makes critical interpretation of content more difficult, especially when sources for content increase in number and types.

The conclusions from the study clearly give rise to a number of design questions regarding the interconnection between between primary and second screens. The next section investigates one of such issues, namely how to transfer content from the secondary to the primary device.

3.4 Transferring videos across devices

In this section we dig further into particular details of user interaction with converging media services in the home environment. Specifically, we investigate the transfer of video content between mobile devices and fixed television sets. The content of this section relies on Fleury et al. (2011a) and especially Fleury et al. (2012b) and thus only presents the motivations behind the study and the main findings from the usability study described in the two publications, in which four content transfer prototypes are tested from a conceptual perspective.

Ubiquitous media and multiple-device environments have recently come to the close attention of scholars from various areas. As introduced in the previous section, a tendency from the literature is to study the integration of mobile devices into the television experience from a control perspective, typically following a second screen approach. In these scenarios, users can manipulate content displayed on the TV screen from the mobile device, and access further functionalities on the phone that complements the TV experience. However transferring content from device to device in such environments has seldom be studied. The following introduces examples of such studies, framing the scenario later investigated in the usability test used as a case study for this dissertation.

From a technical perspective, providing task continuity between television and mobile devices has recently been investigated in research projects such as Migrantes (Paternò et al., 2008) and OPEN (Nickelsen et al., 2010). These projects implemented and tested technical frameworks to support performing media related tasks seamlessly and continuously across a variety of devices. These frameworks implement session transfer mechanisms between two or more devices, which allow users to switch device and resume the task being performed in the same conditions and without the need to physically connect the devices. Focusing specifically on navigating through an EPG on TVs, PCs and mobile phones, (Obrist et al., 2010) provides user insights on how potential end users perceive interface continuity across such devices. In this study test participants appreciated the possibility to browse the EPG using a consistent navigation scheme on a TV, PC or mobile phone. The reduced complexity of the interaction further pleased the families with which the system was tested.

On a more conceptual level, the *Unified EPG* (Obrist et al., 2009) explores the merging of TVs and computers by allowing consumption and production of content from both the living room's TV set and personal computers. Additionally, the service offers social networking functions for recommending shows to peers. Acknowledging the role of the TV set as a consumption device, the service assumes the setting management to take place on the computers, on which virtual channels can be created to be watched on the TV screen. This distribution of tasks between PC and TV was particularly appreciated by participants, which demonstrates the importance of device affordances and the need to carefully consider them when developing multi-devices systems. The interaction on the TV set via the remote control was

however reported complex. This issue was further explored in Obrist et al. (2010), in which the navigation through an EPG was made consistent on TVs, PCs, and mobile phones. This approach dramatically reduces cross-platform usability issues, and encourages switching from one device to another according to the context of use more easily.

These scenarios, among others, rely on the information being distributed across the various devices considered. Focusing more specifically on how to actually transfer content between a mobile device and a television set, Rukzio et al. (2006), Scheible et al. (2008) and Peng et al. (2009) suggested the following four interaction schemes, which are the base of the experiment described below.

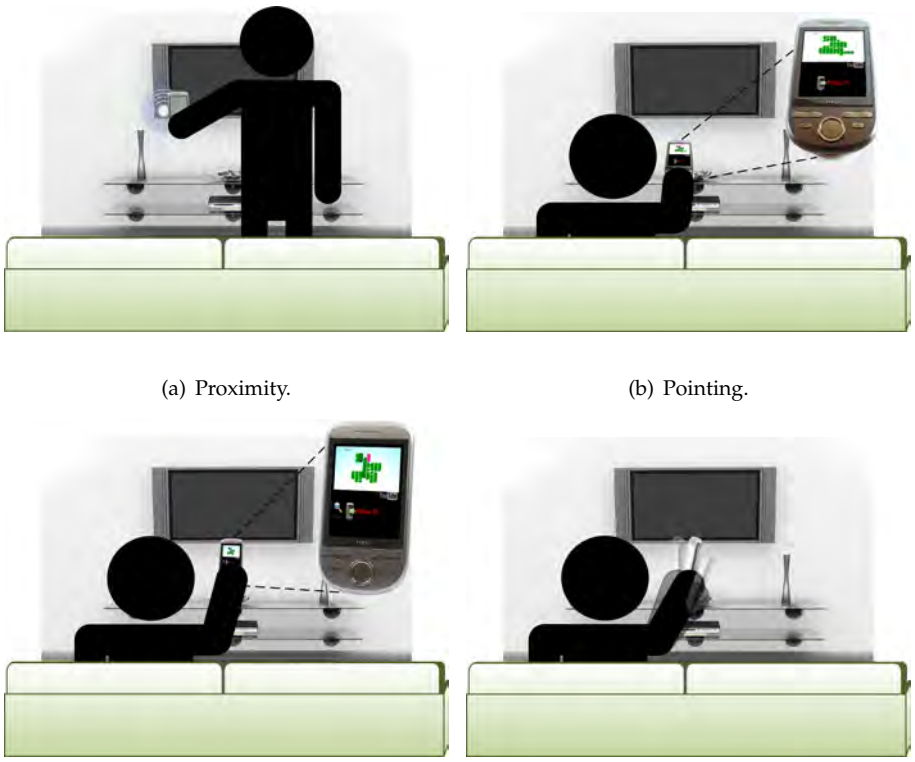
Touching (Rukzio et al., 2006) Conceptually similar to regular short cable connections, the user here has to physically approach a fixed device with the mobile device in order to transfer the content. Previous research has shown that users in general are quite willing to use touching as means of interaction with devices when such devices are nearby, especially when security issues exist or when the risk of ambiguity is a concern. In the present case, the user is not required to bring the devices to actually touch one to another. We therefore prefer to refer to this interaction scheme as **Proximity**, for which the connection enabling criterion is similar to near field communication (NFC), about 4 cm.

Pointing (Rukzio et al., 2006, Peng et al., 2009) With this action, which relies on the remote control interaction paradigm, the user simply points at the device that is to take over the playback of the video from the mobile device. When pointed to a compatible device, its name appears on the mobile for the user to click on in order to initiate the transfer of content.

Scanning (Rukzio et al., 2006) Here the mobile device scans for nearby (i.e. in the same room) equipment and generates a list of devices capable of taking over the presentation of content from the mobile device. The user then selects a device from this list and the handover is initiated. Rukzio et al. have shown that this approach may be seen as a very technical way of interacting with devices and that users therefore tend to avoid it when possible–unless the device in question is outside touching or pointing range. However its similarity to searching for a file on a computer makes scanning a natural option for initiating content transfer between devices. Due to this analogy with the PC world, we refer to this interaction scheme as **Browsing**.

Tossing (Scheible et al., 2008) This action encompasses a method with which the user literally tosses the content from a mobile device to a fixed one, conceptually similar to interacting with the Nintendo Wii. Scheible et al. have shown that tossing as means of interaction is fun to use, although slightly difficult to grasp.

These four methods, illustrated in Figure 3.20, describe well the interaction space made of the novelty and physical activity dimensions. Indeed the assumed associations between the methods and various common multimedia



(a) Proximity. (b) Pointing.

(c) Browsing. (d) Tossing.

Figure 3.20: The four methods for transferring content from a mobile phone to a TV set.

equipment (Proximity-cable, Pointing-remote, Browsing-computer file system and Tossing-Wii) describes an increasing level of novelty based on the time the equipment has been available to mass markets, thus ranging from very old (Pointing) to old (Browsing) to novel (Proximity) and to very novel (Tossing). Similarly, the physical gestures involved in the methods represent an increasing level of activity ranging from finger (Browsing) to hand/arm (Pointing) to arm (Tossing) and to body (Proximity). This interaction space and how the four transfer methods map it are depicted in Figure 3.21.

Transferring videos from a mobile phone to a TV

The usability experiment reported in Fleury et al. (2011a, 2012b) was conducted as a Wizard-of-Oz (WOz), which allows full control of the technical setup by a researcher, hidden from the test subjects. The four transfer methods introduced previously were implemented as prototypes and tested by participants in a random sequence, accessible via a menu on the mobile device (depicted in Figure 3.22). From the participants' perspective, all prototypes were functioning flawlessly relying on technological mechanisms not discussed during the experiment. Further details about how the WOz was conducted

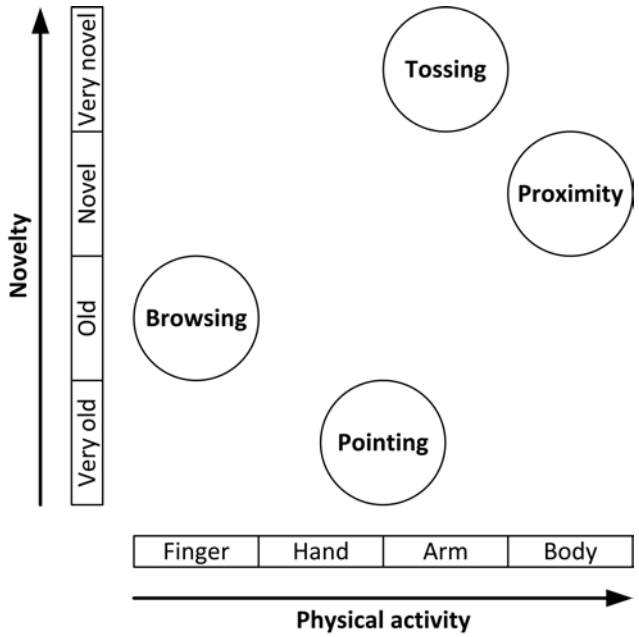


Figure 3.21: The four transfer methods describe the novelty / physical activity space.

are provided in Section 6.4. The following presents the main findings of the study, conducted in two steps.

Step 1: deducing preference indicators

The purpose of this first phase of the experiment was to identify general preference indicators for the four methods. In order to do so, all test participants tried the four methods in a random order under the guidance of a facilitator. They were instructed to orally express their feelings about each method immediately after experiencing it, and after having tried them all, to name and justify their preferred method. Based on these comments, no strong conclusion could be drawn concerning method preference, despite a seemingly dislike for the Proximity method.

In addition to a general opinion toward each method, this process generated 172 useful statements which were classified and collapsed into 20 categories by semantic similarity. A principal component analysis (PCA) then helped identify the following six most salient indicators of preference: reliability, familiarity, convenience, cleverness, annoyance, and intuitiveness. Investigating the role of these indicators as preference predictors was the purpose of the second step.

(a) Menu. (b) Pointing.

(c) Browsing. (d) Tossing and Proximity.

Figure 3.22: The mobile interface of the menu and the four transfer methods.

Step 2: evaluating the indicators

The preference for the four methods was further investigated in the second test phase. According to how participants ranked the methods, it could be deduced that Browsing and Pointing were significantly preferred over Proximity and Tossing, indicating the importance of keeping the levels of novelty and physical activity low. With regard to the six preference indicators, the signifi-

cant relationships described in Figure 3.23 have been established for the four methods. Interestingly, the four methods were perceived equally intuitive.

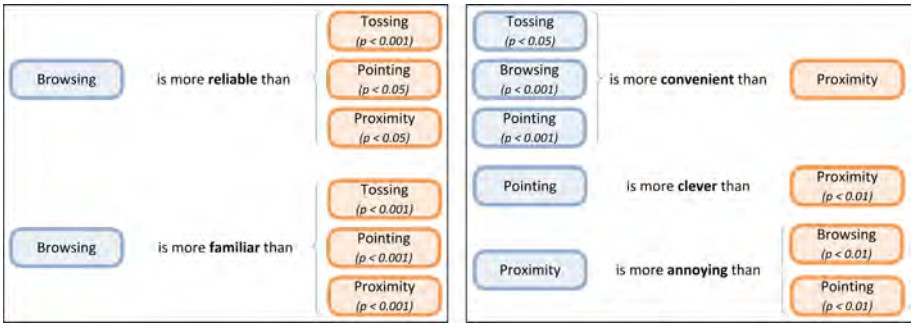


Figure 3.23: Significant relationships between the four transfer methods.

Furthermore, out of the six preference indicators, the levels of familiarity, convenience and annoyance are sufficient to determine method preference with a 80% accuracy.

Design recommendations

Based on the findings briefly reminded in the previous paragraphs, the following design guidelines are suggested for future development of systems implementing multimedia content transfer between mobile and fixed media appliances.

- Levels of reliability, familiarity, convenience, cleverness and annoyance vary significantly among various methods for transferring video material from a mobile device to a TV set. The design process of such systems should thus integrate mechanisms for evaluating these indicators.
- Furthermore, the design of such systems should be grounded in well-known practices already commonly in use in the home media environment. Indeed the noticeable "wow-effect" due to the novelty of the more exotic methods investigated in this study wore off as soon as participants reflected on the method and compared them to familiar interaction schemes.
- Indeed content transfer methods should be designed in ways that arouse familiarity and convenience while preventing traits that could give rise to annoyance. This claim might seem obvious, however we think necessary to remember that rushing into designing novel systems without considering these three parameters could lead to unsuccessful yet costly solutions.

Concluding remarks

An interesting discussion related to this content transfer experiment emerges as one questions the perception of what is being transferred. Conceptually, even though it might seem that the video is being sent from the mobile phone

to the television, only the viewing session is actually transferred between the two devices. Additionally, this conceptual distinction is supported by the technical implementation of the prototype, which is believed to mimic a realistic approach to distributed media access. In fact, the video played on either the mobile phone or the TV is located on neither of the devices, and instead comes from the cloud, a remote location irrelevant to the task. In the present example YouTube acts as such a cloud service, however in case of privately owned material, the actual content file could also be stored on a personal home server accessible from any device belonging to the home media ecosystem. In the end, what matters is no longer where the file is, but what device can best handle it in the current context.

Despite some limitations in the experimental setup, the findings obtained through the usability evaluation of the four content transfer methods are a solid basis for further investigations of ubiquitous media systems within the home environment. Overall, the positive reaction of participants to the possibility of seamlessly migrating content from one device to another are encouraging and representative of the current trends in the living rooms. Media devices are plenty and ubiquitous, and thus require a greater effort in improving ad-hoc connectivity and synchronization. People seem to want their media devices not only to be dedicated to specific tasks or contexts (Kernal, 1999) using a dedicated interface (Jonsson et al., 2004), and to offer a great user experience under those conditions, but also to support additional tasks normally performed with other dedicated devices or in another context, even at the expense of some usability. For instance one might choose to keep on watching videos on the small screen of a mobile phone if the effort required to transferring the video to another more suitable display is considered too high. Simple transfer mechanisms could therefore alleviate such issues and offer greater multi-device media experience.

The study presented here could benefit from the actual implementation of the transfer methods to improve ecological validity by taking into account technical constraints and potential reliability issues. Additionally, investigating alternative transfer methods with a broader range of participant demographics would constitute a logical next step to this study.

By exploring a specific usability issue with converging media technology, this section concludes the first part of this dissertation. The next section will briefly summarize the findings collected so far, before opening for the methodological discussion held in Part II.

CHAPTER 4

SUMMARY OF PART I

This chapter aggregates the findings collected throughout the ten user studies described in the first part of this dissertation. The following sections describe the most salient findings and offer a first level of interpretation thereof, roughly categorized according to the *home setting* versus *mobility* dichotomy. In addition to those two overarching categories, the most striking similarities and differences observed between Scandinavian and East Asian countries (represented by Denmark and Japan) are summarized.

4.1 Media at home

Home is obviously a key environment when studying media consumption. The three most discussed topics related to the home media environment throughout our user studies are concerned with 1) televisions, 2) second screens, and 3) the integration of home media appliances.

Televisions

Even though it is nowadays complemented by other types of devices offering access to various types of media, TV (and its flow TV content delivery model) remains an essential part of the home media life. Television sets are traditionally ubiquitous, and people attach different types of memories to them. In fact, despite the increasing penetration of PCs, laptops, mobile phones and tablet computers, television consumption remains stable over time. It is however important at this stage to distinguish between TV as a device and TV as content. As the other devices increasingly provide access to television material, the device tends to lose its importance even though its functions remain highly relevant. As before, television is used for accessing information and getting entertained, but the TV set as such is no longer the only source of television content.

In addition, it is recognized that television is less about its content than about the intricate social ties that pertain to it. People have always been active in front of TV, engaged either in discussions with co-viewers, or involved in tasks (usually mundane and non-media related) to which the TV serves as a background. These practices are still dominant today, and are expected to remain so in the future. However the introduction of communication gadgets that fit in the hand or on the lap brings about the possibility to open the discussion toward outside the immediate circle of co-viewers. Examples of resulting new practices include co-watching concurrent channels (one on the primary screen–usually a TV set, and one on a secondary device), and the inclusion of remote friends in debates related to a show watched at the same time. Additionally, discussions increasingly take place between the audience and production teams, who can integrate user-generated content (be it votes, comments, or videos taken via mobile phones) into the programme.

The attitude of TV audiences is thus slowly evolving. A portion of viewers, encouraged by new TV show formats, engage with TV content via services available through mobile phones, tablets, or laptop computers. These practices, referred to as second screen viewing as they involve another device on which content is accessed and/or manipulated, were the second central topic of our user studies. The findings from those studies are summarized in the following paragraphs.

Second screens

Such practices, although only burgeoning and still under evaluation by broadcasters and researchers, are expected and waited for by end users. In particular, being able to check other channels and to retrieve more information about the current programme are two highly appreciated features. The possibility to submit UGC to shows triggers interest and is perceived suitable for some shows. Some challenges of course remain to be tackled before the proliferation of interactive TV programmes, especially those for which viewers become co-editors. For a start, only some genres are suitable for second screen based interactive features. Entertainment and particularly contest shows are mostly targeted so far, but sports, children programmes, and news can be expected to follow in the near future. Other challenges faced by production teams of these new types of shows come from their own organizations. Indeed, even past the generation gaps clearly observable within leading broadcasting corporations, broadcasters are still unsure about the return on investments generated by such programmes, and therefore invest in those very cautiously. The primary results obtained from trials, the positive response from audiences, and the increased affordability of the technology required to create these programmes are however three factors expected to motivate broadcasters to further explore the possibilities offered by second screen applications and other such new media.

Our studies uncovered the following requirements for second screen services to be successful.

Easy to access and use for smooth integration into the TV experience, and minimal distraction from the show

Optional so viewers opt-in or out as they wish

Filtered to avoid irrelevant or poor quality user-generated material; however who should be in charge still being up to debate

Bundled as one app for all interactive TV features, regardless of the channel or programme

Uncluttered primary screen to minimize distraction from the show

Content/Interaction separation when in front of TV, broadcast content belongs to the primary screen (TV set) and interactive features belong to the secondary device (smartphone, tablet, laptop)

Content/Interaction integration combining broadcast content and interactive features on the second screen is required when away from the TV or when the primary device is occupied

Direct solicitation on the primary screen should drive viewers' attention to the secondary screen

Allowing viewers to participate in live TV shows with user-generated content creates concerns about privacy issues, censorship, and potential hidden advertisement. In order to to tackle these, contributors wish to remain anonymous, although are expected to be held responsible for their submissions. This mechanism should participate in the quality control of the material submitted. UGC should also be acknowledged by the programme editors, with whom the audience expects to be in dialogue, rather than merely providing content without receiving feedback.

The high interest in second screen setups can be explained by the already active behaviour of TV viewers, and the proliferation of diverse connected devices that are easy to use from the couch. As discussed next, the third most discussed topic through the user studies is related to technological convergence from the perspective of device synchronization and content transfer.

Integration of home media appliances

Not only they are used simultaneously, but increasingly home media appliances are connected to each other, turning homes into networked ICT environments. Although such solutions are yet to become widely available, the upcoming democratization of quadruple play offers symbolizes this tendency. Telecom operators are developing and releasing media packages including television, Internet, as well as fixed and mobile telephony. As a result, content is accessible from a growing number of platforms, revolving around a kernel of central devices: TVs, PCs, tablets and smartphones. Transferring material between devices however remains somehow a challenge. Physical connections via cables suffer from distance constraints, memory cards are cumbersome and present compatibility issues, wireless solutions are still complicated to set up. If today they overcome these technical difficulties, people

welcome new and more convenient solutions that resemble existing interaction schemes yet minimize the annoyance they can cause. Improving the integration between devices by implementing such new interaction schemes will further enhance mediated user experience and is another step toward the realization of true ubiquitous media.

The integration of various media devices makes sense in the home context as one can take advantage of the benefits of each device according to the task at hand: the large dimensions of the living room TV screen for optimal shared TV experience, and the unmatched interaction scheme of the PCs for information retrieval, to name a few. However when away from the TV set, or simply when no other device is available, mobile devices reveal their potential as a personal portal for media experiences available in the pocket. The next section discusses the mobile related issues explored through our user studies.

4.2 Mobility

The two aspects of mobile media lives the participants of our studies shed light on are 1) their experience with mobile devices in general and mobile phones in particular, and 2) mobile television.

Mobile phones

The ubiquity of mobile phones in ICT societies is obviously not to be demonstrated any more. In fact, mobile phones are so omnipresent in our everyday lives that associating memories with them turns out to be a difficult task. Mobile phones are convenient, personal, private, small and active. People carry them around everywhere and constantly rely upon them for communication purposes as well as for performing a plethora of secondary activities, such as checking emails and surfing Internet. These activities take place anywhere, even while watching TV as the second screen discussions revealed. A few factors tend to further indicate that mobile phones are becoming the keystone of personal media ecosystems. In addition to continuous improvements of processing power and the development of cloud computing making documents available literally at any time and from anywhere, mobile phones act increasingly as a personal identifier granting access to information or authenticating its owner. For instance mobile payment solutions are already implemented in Japan, and progresses in this areas are visible worldwide.

Interesting perspectives on the emotional attachment people have with their mobile phones emerged from our user studies. For instance people would feel sad and angry if they could no longer use their phone, feelings not so much attached to less personal media devices such as TVs. Also contrasting with television, memories attached to mobile phones are solitary and mostly related to use and misuse of the device. The design of the device is also very important for people, as the phone itself is as valuable as its functions.

One function extensively discussed throughout the user studies is the possibility to watch live broadcast television on mobile phones. This is the topic of the next few paragraphs.

Mobile TV

A few years ago mobile TV was announced as the next revolution in mobile technology. Since then we have indeed witnessed the appearance of television content (including live broadcast) onto mobile devices, however without the dramatic effect anticipated by some. Rather, broadcasters and audiences perceive mobile devices as yet another channel for distributing or consuming television content. In regions were the service is available, people watch and wish for the same type of content than on regular TV. The service is praised for its ease of use and the convenience with which TV content is accessible on the go. The service is particularly used to catch up with news and following specific events such as sports. Concerning the contexts in which mobile TV is used, previous findings were confirmed as commuting time and evenings are seemed most relevant. Home and public transport are thus the most common places for watching TV on one's mobile phone. Even on mobile, TV watching remains a social activity: dedicated devices are shared among family members and watching sessions are shared among friends. Interestingly people consider watching mobile TV similar to other common media consumption practices in public such as reading a newspaper or listening to music. As a result, people are comfortable with the idea of watching TV surrounding by strangers, although this requires the use of headphones.

A number of critical usability issues still need to be addressed in relation to mobile television. Among those, too long channel switching durations, unreliable reception quality, and audio/synchronization issues need the most urgent attention. Nevertheless, watching TV content on a small screen is enjoyable due to high screen resolution and perceived good audio quality. The service is also praised for its handiness and availability. The simplicity of use of the service also greatly contributes to satisfying its users.

It should be noted that those findings are generalized from studies conducted in two culturally very different regions with varying access to the services discussed above. In addition to the common trends discussed so far, some differences were also uncovered, as briefly summarized in the following paragraphs.

4.3 Regional particularities in Scandinavia and East Asia

Although a systematic comparison of Danish an Japanese markets was not the purpose of any of the user studies reported previously, some differences between the two regions have been observed by studying how Danes and Japanese perceive and use televisions and mobile phones. The following describes these differences.

Televisions

TV-related memories are centred around content in Japan, while Danes also consider the device as such and the social surroundings. In Japan they are experienced mostly alone and recall negative, neutral, or positive feelings. News is the top most popular genre watched in both regions, but Danes watch as

much films as well while Japanese don't. Danes like their TV for its content and purpose, to which Japanese prefer performances. Danes engage slightly more than Japanese in multitasking (using other media or not) when watching TV. Danes are also more likely to check other channels on a secondary device than Japanese. However only Japanese report working or studying as one of their main main activity in front of TV. The inclusion of unedited user-generated content is currently more common in Denmark than in Japan, even if in both cases the concept is in its infancy.

Mobile phones

The Japanese are bigger mobile phone users than the Danes when it comes to accessing Internet (and especially social networks), checking emails, and taking pictures. This comes from the early development of mobile Internet, as early as 1999. In fact, the mobile phone is the default Internet access equipment owned by Japanese when costs are an issue. Japanese also have a broader definition of what constitutes a mobile device and are more emotionally attached to their mobile phone than Danes are. However the Danish market shows significantly higher penetration rate of smartphones than in Japan, although the definition of smartphones remains debatable. Additionally, the emotions illustrated in the memories drawn by Japanese toward mobile phones are mostly negative, while they are more ambiguous in Denmark. Interestingly, even though mobile TV sparkles little interest in the two regions, Danes show more interest than Japanese for watching TV on their phone while commuting, during short breaks at work and while waiting for public transport. Specific to Japan, mobile TV is perceived useful in case of disasters and while performing other tasks around the home.

Part II

User experience evaluation

"You cannot acquire experience by making experiments. You cannot create experience. You must undergo it."

Albert Camus

In this second part of the dissertation, the techniques employed to generate the findings presented in Part I are exposed. They are divided into two categories, according to whether they are used to explore conceptual aspects of user experience with converging media (Chapter 5), or to evaluate some of its aspects with prototypes (Chapter 6). Taking a close look at these methods, and more specifically to the conceptual ones, will help answering the third sub-research question II.a formulated in introduction: *How to discover personal stories related to media practices in multi-cultural settings and with tight time constraints?* Finally, Chapter 7 shortly recapitulates the main findings from Part II.

Evaluating user experience

A definition of User Experience

Currently it is admittedly difficult to select the right approach for conducting user experience (UX) research, given the number of available methods, techniques and tools. The mere definition of the term "user experience" is subject to intense discussions. Most of the debate focuses on how UX differentiates itself from its related fields and associated terms, such as usability, interaction design, information architecture, human-computer interaction, human factors engineering, or user interface design (Paluch, 2006). Other "experiences" often related to UX include customer experience, brand experience, product experience and service experience. In December 2011, allaboutux.org referred to 27 definitions of user experience[1] from various researchers and practitioners. These diverse interpretations illustrate the common trends and divergences animating the field. Recently, a group of researchers led by Effie Law has been working on identifying a common definition of the nature and scope of UX, by organizing workshops (Law et al., 2006, 2007), special interest groups (Law et al., 2008), and surveying academic and industrial experts (Law et al., 2009). The result of this attempt at identifying a common ground for the nature and scope of user experience is detailed in Law et al. (2009). In summary, more than being about being user-friendly and intuitive, UX is perceived as dynamic, context-dependent and subjective, characteristics also put forward by Hassenzahl (2010). However no standard definition has been commonly agreed upon yet. A potential explanation for this unstable characterization of UX is the field's inherent multidisciplinarity. Indeed, UX is shaped by and benefits from each of the various aforementioned domains it relates and contributes to. Law et al. argues that UX integrates a broad range of concepts that are utilized at the discretion of the researcher or practitioner, which combined with the theoretical background s/he belongs to, skews UX' understanding toward a narrow focus. Furthermore, Law et al. finds the framework for evaluating UX is too loosely defined, resulting in contributions inconsistent in scope. As a result, it seems therefore not only hard, but maybe also unnecessary, to integrate all these perspectives into a single common definition. Nevertheless, Law et al. considers a more rigid description of UX necessary for various reasons: simplifying communication between scholars and practitioners from different backgrounds, facilitating the practical application of UX, and helping teaching UX. The reader further

[1] UX definitions: http://www.allaboutux.org/ux-definitions (December 4th, 2011).

interested in this on-going discussion about the definition of user experience could start by reading the white paper available on allaboutux' website[2], as it provides an updated perspective on the matter.

In the following chapters, this thesis understands user experience as the combination of the following three overlapping definitions.

> *"All the aspects of how people use an interactive product: the way it feels in their hands, how well they understand how it works, how they feel about it while they're using it, how well it serves their purposes, and how well it fits into the entire context in which they are using it."*
>
> (Alben, 1996, p. 12)

> *"A consequence of a user's internal state (predispositions, expectations, needs, motivation, mood, etc.), the characteristics of the designed system (e.g. complexity, purpose, usability, functionality, etc.) and the context (or the environment) within which the interaction occurs (e.g. organisational/social setting, meaningfulness of the activity, voluntariness of use, etc.)'*
>
> (Hassenzahl & Tractinsky, 2006, p. 95)

> *"Every aspect of the user's interaction with a product, service, or company that make up the user's perceptions of the whole. User experience design as a discipline is concerned with all the elements that together make up that interface, including layout, visual design, text, brand, sound, and interaction. UE works to coordinate these elements to allow for the best possible interaction by users."*
>
> (Usability Professionals' Association[3])

UX evaluation toolbox

If defining user experience seems difficult in the light of the previous introduction, identifying and classifying UX evaluation methods can be an even more tedious task. The following paragraphs introduce some of the dilemmas faced by UX researchers when deciding on a test strategy, review two state-of-the-art classifications of available techniques, and apply those schemes to the methods further discussed in this part of the dissertation.

[2] UX white paper: http://www.allaboutux.org/uxwhitepaper (December 4th, 2011).

[3] Usability Professionals' Association's definition of user experience: http://www.usabilitybok.org/glossary (December 4th, 2011). UPA recently renamed itself to UXPA, or User Experience Professionals' Association, following the industry shift from usability to UX (Battista, 2012).

Quality or quantity?

Exploring detailed aspects of people's life can be done in many ways. Standard ethnographic methods include interviews (in-depth, repeated), activity logging (automatic or via diaries) or remote prompting. These methods help researchers immerse into people's life more or less deeply and over various periods of time, from a specific point in time to several weeks, months or even years. These methods, among the plethora of user research tools available, vary greatly in the type of data they allow to collect. One differentiating factor divides qualitative data from quantitative data. On the one hand, data collected using qualitative inquiry methods provide in-depth perspectives on the object of study, usually from a holistic point of view and from a limited sample of test subjects. On the other hand, quantitative methods allow to draw statistically verifiable conclusions from a larger population, focusing on more specific aspects of the object of study. As an example from mobile television related studies, the social implications of watching mobile TV at home would be most likely investigated qualitatively through personal interviews with a few families, while validating the navigation scheme on the mobile EPG would typically call for questionnaire-based cognitive walkthrough or other similar quantitative usability testing methodology.

The distinction between qualitative and quantitative methods stems from the classic differentiation between positivistic and phenomenological research schools, largely discussed in the literature and briefly summarized in Amaratunga et al. (2002). In essence the phenomenological approach is interpretive and aims at understanding the object of study as a whole and not as a combination of individual events. Instead, logical positivism searches for causes, and in order to do so partitions the problem into smaller issues for which hypotheses can be formulated and tested by observers who remain independent from the subject observed.

Most ethnographic methods are qualitative in nature. According to Hughes et al., system design can rely on four different uses of ethnography: 1) concurrent ethnography, taking place at the same time as the ongoing design process, 2) quick and dirty ethnography, which consists in brief studies to provide a "general sense of the setting for designers", 3) evaluative ethnography, undertaken for validating already made design decisions, and 4) re-examination of previous studies, which are revisited to inform initial design thinking (Hughes et al., 1994, p. 432).

However efficient these methods are, they suffer from being time consuming in planning, conducting and analysing. Sometimes one might need a snapshot of a specific part of people's life from a sample of participant bigger than what can be afforded using the aforementioned methods. Decreasing the resources necessary to measure personal user experiences has been on the agenda of HCI researchers, and thus rapid UX evaluation strategies have been developed and applied. Beebe introduced and defined "Rapid Assessment Process" (Beebe, 2001), and Miller further proposed to focus on three key aspects of evaluation design: 1) Focus and key informants to limit the amount of data collected, 2) Interactive observations to improve the qual-

ity of the data collected, and 3) Collaborative data analysis to help analysing the data collected (Millen, 2000). These evaluation strategies are aligned with Nielsen's notion of discount usability testing, also referred to as "guerrilla" HCI (Nielsen, 1994a). Similarly, the notion of agile user-centred design have been also encompassed by many, as reviewed in Hussain et al. (2009), which shows that low-fi prototyping, conceptual design, observational studies of users, and usability expert evaluations are the most used techniques by HCI professionals.

Specific to mobile technology, the past decade has seen the emergence of new evaluation techniques, due to the realization that traditional methods face methodological challenges when applied to the contexts relevant to mobile technology. The literature reviews reported in Kjeldskov & Graham (2003), Hagen et al. (2006) and Wei (2007) describes a wide range of both qualitative and quantitative methods currently in use by mobile HCI research teams.

This thesis adopts the recognized position that not only qualitative or quantitative methods should be applied to conduct user research, but instead a research strategy based on combining both types of methods provides a deeper and broader understanding of the topic under scrutiny. This approach, referred to as *triangulation*, is defined as "*the use of multiple methods in the study of the same object*" (Denzin, 2009, p. 301). Originally conceived in the 1960s, it has since been largely advocated in the literature of various fields, including HCI (Mackay, 1998, Wilson, 2006). According to these authors, triangulation can occur across methods, disciplines, as well as a number of experimental parameters: facilitators, observers, user groups, and geographic background. As exposed in Jick (1979), the difficulty of this approach resides in the post experimental evaluation of the results from the various methods employed, and the verification of their convergence. Indeed, Jick questions how to compare significant differences established qualitatively and quantitatively, and how (if) the data collected through various methods should be weighted in order to be compared. Only careful experimental design and analysis of congruence in the data collected can help tackle those issues and provide solid results, stimulate new research strategies, identify elements that do not fit any theory or conversely integrate various theories (Jick, 1979).

In vitro, in situ, or in between?

An intense discussion among UX researchers has been ongoing during the last decade concerning the necessity to conduct experiments in real, unsupervised environments (referred to as field experiments, experiments "in the wild", or "in situ"), as opposed to laboratory-based, controlled environments. The main opposing arguments put forward in this debate are the level of control offered by laboratories compared to the ecological validity achieved in real-life contexts. Moreover, field experiments are time consuming and their added value compared to their laboratory counterpart is questionable (Kjeldskov et al., 2004). Specifically, user-centred design of ubicomp application face issued of sensing (reacting to live data) and scaling, as they involve numerous tasks, actors, devices, and places (Carter et al., 2008). For the same reasons, require-

ment elicitation for such systems seems best performed in situ, but requires new observation techniques (Seyff et al., 2008, Brill & Knauss, 2011). Mobile applications are especially difficult to evaluate in the field due not only to the complexity of mobile contexts, but also to varying connectivity conditions, small screen size and display resolution, limited processing power, and challenging data entry methods (Zhang & Adipat, 2005). As noted in Jambon et al. (2006, 2008), Kjeldskov et al. thoroughly investigated this issue and their early pro-control stance evolved over the years and experiments toward a more fidelity concerned position (Kjeldskov & Skov, 2003, Kjeldskov et al., 2004, 2005, Kjeldskov & Skov, 2007). The benefits of conducting mobile usability experiments in the field have furthermore been emphasized in other studies, such as Nielsen et al. (2006), in direct reply to Kjeldskov et al. (2004). However in this specific case, one should notice that the "field" experiment which yields better results in terms of number and quality of usability issues, is in fact conducted in a very controlled setting (an empty warehouse dedicated to training students), and the recording equipment and personnel were arguably ecologically invalid (a facilitator constantly followed the participant who manipulated a mobile phone on which was mounted a mini camera to record user interaction). Nevertheless, increased environmental realism calls for further examination of the definition of situated studies, and for finding the right balance between control and realism.

Following Kjeldskov & Skov (2007), we consider the control/realism axis to describe three experimental setups, as illustrated in Figure 4.1: 1) *in vitro*, offering the highest level of control and the lowest level of realism, 2) *in situ*, with opposed characteristics, and 3) *in sitro*, which balances the two dimensions. Another differentiation scheme has been suggested in Jambon et al. (2008), which separates experiments according to whether they are conducted in a laboratory (highly controlled and supervised), in the field (little controlled yet supervised), or in real situations (uncontrolled and unsupervised). According to this classification, the dilemma faced by research teams when selecting either of these options is best expressed as a result of the observer effect, according to which the evaluation of a phenomenon affects the phenomenon itself. The desired tradeoff between precise observation and usage situation fidelity is thus the main determining factor. As further discussed in Section 6.3, in sitro experiments seem to currently offer optimal results in terms of experimental control and ecological validity.

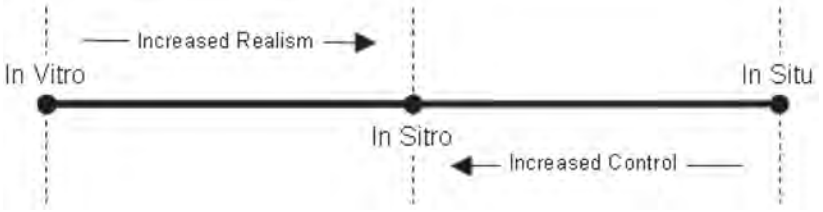


Figure 4.1: *Simplified illustration of the often claimed trade-offs between a high level of control and a high level of realism in in situ and in vitro evaluations.* Reproduced from Kjeldskov & Skov (2007).

Nevertheless, it is tempting to test mobile application in their intended usage context with minimal experimental bias. Strategies have been developed to minimize observer effect in real situation evaluations. For instance, one way of recording video data without relying on a cameraman is to place mini cameras on the user and the test device, as for instance in Roto et al. (2004) and Kaikkonen et al. (2005). However this approach has been argued to remain too intrusive as the cameras are clearly visible depite their small size not only by the test subject but also by people in the vicinity Jambon et al. (2008). Instead, Jambon et al. describe how this issue can be alleviated by adopting a "Trojan horse" approach and integrating the recording equipment as part of the experiment, justifying its presence. For instance a video camera placed on skier helmets can be not only used by researchers to observe the skiers' interaction with a mobile application, but also by the participants to watch their performance on the mobile device.

Another approach to record user experience within mobile settings is to set up unobtrusive, automatic data logging systems. Today's mobile technology allows capturing a wide range of interaction- and context-related data (from virtually any sensor available on the mobile device), which decreases the need for control parameters (facilitators, recording devices) to follow on-the-move users of mobile applications. Two such tools are RECON and GREATDANE (Jensen, 2011b,a), the former focusing on capturing application-related information (specific interaction, general device use, and contextual parameters relevant to the application), while the latter transforms the "reality traces" (raw information) captured by RECON into meaningful information. These tools have been deployed and tested with various ubicomp applications. They have a number of benefits when it comes to conducting user evaluations, including optimized ecological validity, and scalability in time and number of participants. The data captured however contains a large amount of noise, from which it can be difficult to draw accurate conclusions. Moreover, these studies rely on sophisticated platforms not always available, and on the user to perform potential maintenance tasks. When setting up such autonomous logging campaigns, strategies should be devised to deal with privacy, security and ethical issues concerning the possibly highly personal information accessible on mobile devices (Jensen, 2011a). Finally, the study participants themselves can be responsible for capturing the data. For instance they might be asked to take pictures of elements or scenes relevant for the study, as for instance in Tamaru et al. (2005) where mobile workers documented typical work days with a disposable camera. Or they might record video clips of scenes depicting typical usage of a product, as proposed with the *Experience Clip* technique (Isomursu et al., 2004).

Exploring the collection of UX methods

As of December 2011, allaboutux.org collected 81 of such methods, categorized according to their type, the development phase they are to be applied, the period of experience studied, and the source of information used, as reproduced below.

1. Method type
   a) Field
   b) **Lab**
   c) Online studies
   d) Questionnaires/scales
2. Development phase
   a) **Concept**
   b) Early prototype
   c) Functional prototype
   d) Market product
3. Period of experience
   a) Before use
   b) **Snapshots of experience**
   c) **A specific task/activity**
   d) Long term
4. Source of information
   a) Experts
   b) **One user**
   c) Pairs of users
   d) Groups of users

As depicted in Table 4.1, the user studies conducted in the context of this thesis span nearly all the above-mentioned categories. However, the bold-faced methods in the previous list are most largely represented in the present work. This preference is consistent with allaboutux.org's own categorization of methods in terms of period of experience and source of information. Diverging from allaboutux.org's scheme, the studies have been more frequently conducted in a lab, and development phase of prime interest for this thesis is slightly skewed toward the conceptual phase.

Another classification has been performed and is maintained by the Open Living Lab Knowledge Center[4]. Here, contributors differentiate methods, techniques, tools, and sensors. *Methods* are high-level approaches to answer particular types of research questions. *Techniques* are specific procedures to collect data. *Tools* are instruments to collect the data in real life or analyse the data. *Sensors* and/or software solutions measure the behaviour of the participants and/or the context in which this takes place.

Only the methods and techniques are relevant to this section and will thus be further discussed. Nine methods are presented, categorised according to the development phase they are relevant for, and the type of research questions they help answer.

1. Development phase
   a) Discovering user needs
   b) Developing concepts together with users
   c) Designing prototypes together with users
   d) Designing end-products together with users
   e) **Evaluating concepts with users**
   f) Evaluating low-fidelity prototypes with users
   g) Evaluating high-fidelity prototypes or end-products with users

[4]Open Living Lab Knowledge Center: http://knowledgecentre.openlivinglabs.eu (December 12th, 2011).

Table 4.1: Distribution of user studies used in this thesis according to allaboutux.org's classification scheme.

Studies	Method type				Development phase				Period of experience					Source of information		
	Field	Lab	Online studies	Questionnaires/scales	Concept	Early prototype	Functional prototype	Market product	Before use	Snapshots of experience	A specific task/activity	Long term	Experts	One user	Pairs of users	Groups of users
#1	X							X			X			X		
#2		X			X						X					X
#3		X				X					X			X		
#4		X			X						X			X		
#5		X			X					X				X		
#6		X				X				X				X		X
#7	X							X		X				X		
#8		X					X				X			X		X
#9				X	X			(X)	X	X	X	X	X			
#10			X		X			X		X				X		
All	**2**	**6**	**1**	**1**	**5**	**2**	**1**	**4**	**1**	**5**	**6**	**1**	**1**	**8**	**0**	**3**
Ref.*	52	61	32	19	22	19	66	71	24	35	60	28	9	70	5	7

(X) indicates partial match. *Number of methods listed by allaboutux.org.

2. Research question
    a) You want to observe changes in user behaviour over time
    b) **You want to compare alternative designs of a product or service**
    c) You want to get a detailed insight in a user's past experiences
    d) **You want to get a detailed insight in a user's current practices in real life**

The studies conducted in the context of this thesis cover all research questions and the most frequent deployment phases accounted for in the Open Living Lab classification scheme, and their frequencies of use are distributed similarly across the categories. The most represented deployment phases and research questions are boldfaced in the above list. Table 4.2 illustrates the distribution of the studies conducted during this thesis according to this scheme.

In addition to the development phase they are to be applied, the 21 techniques gathered on the website are categorised according to the type of measurement to be performed, and type of data collected.

Table 4.2: Distribution of user studies used in this thesis according to the Open Living Lab methods classification scheme.

Studies	**Deployment phase**							**Research question**			
	Discovering user needs	Developing concepts together with users	Designing prototypes together with users	Designing end-products together with users	Evaluating concepts with users	Evaluating low-fidelity prototypes with users	Evaluating high-fidelity prototypes or end-products with users	You want to observe changes in user behaviour over time	You want to compare alternative designs of a product or service	You want to get a detailed insight in a user's past experiences	You want to get a detailed insight in a user's current practices in real life
#1	X						X				X
#2					X						(X)
#3						X			X		
#4						X			X		
#5	X				X					X	
#6		X			X					X	
#7							X				X
#8					X		X		X		
#9	(X)							(X)			
#10	X				X						X
All	**4**	**1**	**0**	**0**	**5**	**2**	**3**	**1**	**3**	**2**	**4**
Ref.*	7	2	1	1	2	4	6	2	2	4	5

(X) indicates partial match. *Number of methods listed by the Open Living Lab.

1. Measurement type
   a) **Measuring user opinions / subjective experience**
   b) Measuring body reactions
   c) **Measuring interactions between the user and a product/service**
   d) Measuring interactions between users
   e) Measuring the interaction between a user and his/her environment
   f) Measuring the environment
2. Data type
   a) **Qualitative**
   b) Quantitative

Omitting the development phase as it has been discussed in relation to the list of methods, the user studies reported in the present research focus on two measurement types (Measuring user opinions/subjective experience

and Measuring interactions between the user and a product/service), and produced slightly more qualitative than quantitative data (see boldfaced categories). This distribution is illustrated in Table 4.3. It should be noted that it highly correlates (Pearson Product-Moment Correlation Coefficient $r = .81$) with the Open Living Lab's classification of the list of techniques it maintains.

Table 4.3: Distribution of user studies used in this thesis according to the Open Living Lab techniques classification scheme.

Studies	**Measurement type**						**Data type**	
	Measuring user opinions / subjective experience	Measuring body reactions	Measuring interactions between the user and a product/service	Measuring interactions between users	Measuring the interaction between a user and his/her environment	Measuring the environment	Qualitative	Quantitative
#1	X						X	(X)
#2	X						X	
#3			X					X
#4			X				(X)	X
#5	X						X	
#6	X						X	
#7			X					X
#8	X		X				X	
#9	(X)		(X)				X	
#10	X		X					X
All	**7**	**0**	**6**	**0**	**0**	**0**	**7**	**5**
Ref.*	17	4	7	4	8	2	18	8

(X) indicates partial match. *Methods listed by the Open Living Lab.

Summarizing the previous analysis, the set of user studies conducted in the present thesis are characterized as follows.

- In general, gradual progression from concept-oriented to market product-oriented studies over the course of the research
- Clear preference for qualitative data collection over quantitative
- Clear focus on measuring opinion and experience as well as user-product interaction

- Clear preference for lab studies over field experiments
- Clear focus on capturing snapshots of experience and evaluating specific situations of use
- Clear preference for individual users as source of experience data collection
- Preference for gathering insight on current practice and comparing various designs of a product
- Focus on concept and prototype evaluations

The following chapters differentiate between *conceptual* and *prototype based* user research methods. On the one hand, the conceptual methods reported in this dissertation investigate user experience from a cognitive perspective, focusing on emotions, memories, and opinions. On the other hand, the prototype based methods discussed here consider UX from a tangible perspective, exploring the use of a concrete, physical object. These two approaches are complementary and are considered equally valuable in terms of discovering and assessing user experience in the course of a long term project.

Final draft

CHAPTER 5

CONCEPTUAL METHODS

5.1 Cross-cultural online survey

In the introduction to a special issue on mobile phone use in cross-cultural context, Baron argues that cross-cultural studies are necessary despite the many cultural factors that might prevent direct comparison of data collected in various countries (Baron, 2010). By especially focusing on mobile phone use in Sweden and Japan, Baron & af Segerstad and Westlund uncovered a number of cultural similarities and differences. From a methodology perspective, Baron & af Segerstad (2010) distributed a 54 question long online questionnaire to 1223 university students from Sweden, Japan, and the USA, while in Westlund (2010) 764 Swedes answered a postal mail survey and 2500 Japanese completed an online questionnaire. These studies form the ground of this section. The following paragraphs report on the methodology used to conduct a survey on *Everyday use of television and mobile phone* in Denmark and Japan, the results from which have been described in Section 2.4. In the following, a short introduction to the field of online research in cross-cultural contexts is first provided, outlining a number of issues relevant to the present study. These issues are then explored more thoroughly and the solutions adopted to tackle them in the case of this research are examined. The results from the survey used as a case study are only available in this thesis (at the time of writing) and are presented in Section 2.4.

Conducting cross-cultural online surveys

The ubiquity of Internet access in the cultures targeted in this research makes it possible, and even desirable, to take advantage of the web to conduct user studies. Like its offline counterpart, Internet research can take various forms, such as remote interviews, online focus groups, crowdsourced usability evaluation, or ethnographic studies. The pros and cons of conducting research

online have been extensively discussed during the last decade, mostly in the social science literature and will therefore not be addressed in details here (see for example Mann & Stewart (2000), Hewson et al. (2003) and Gosling & Johnson (2010)). It is nevertheless worth reminding some of the main advantages and disadvantages of Internet-based research. Time- and cost-efficiency for instance, together with the potential ability to reach very large audiences, have been put forward as the main benefits from remote web-based research. As a concrete example, Accelerant Research (2010) investigated the quality, cost and speed of online qualitative research, and concludes that online platforms such as blogs are effective at collecting large amount of "rich, symbolic, emotional-based" data, for a significantly less monetary cost. Internet is particularly suited for conducting cross-cultural studies, despite a number of challenges to be taken into consideration to avoid discrepancies in the test populations: 1) the cost of Internet access, and the potential limited resources supporting Internet access, 2) gaps in Internet use, due to varying familiarity with the technology, 3) education levels, 4) language related communication issues, and 5) cultural appropriateness of the research tools employed (Suarez-Balcazar et al., 2009).

With regards to the many techniques and tools available to turn studies traditionally conducted via pen-an-paper into online experiments, Birnbaum emphasizes the need to know the basics of web programing languages such as HTML and Javascript, as well as to be capable to set up web-forms (Birnbaum, 2010). In addition to addressing issues inherent to online qualitative research such as privacy and gender, Annette Markham and Nancy Baym's *Internet inquiry* offers deep insights on how to ensure the time, location and cultural meaningfulness of online qualitative research projects, and concludes on defining quality in such projects (Markham & Baym, 2009). Especially, Markham's reflection on cultural appropriateness in global online studies are particularly relevant for the study reported in this section, as the survey reported was conducted in two distinct cultural settings, none of which the author is originally from. Markham notes the following lessons she learned during her own research. These statements reminds us that our cultural background and personal lecture of our environment may disrupt or at least color the findings of qualitative research.

> *"Even the simplest descriptive details are filtered through the researcher's localized understandings [...] Our cultural assumptions will influence our interpretation [...] Culturally specific understandings of power and authority influence the interpretive lens."*
>
> (Markham, 2009, pp. 144-145)

In Baym (2009), quality in qualitative Internet research is argued to be reached by adopting the following guidelines.

Connect to history Despite Internet's novelty and fast, constant evolution, online research should be grounded in existing theories and methods.

Focus Internet research should start from a specific inquiry that narrowly scopes the field explored, even though the focus might slightly evolve along the research.

Be practical One must control and limit the extend to which collecting data, and consider the resources available.

Anticipate counter-arguments Baym suggests ways to prepare for potential criticism of one's work, including paying careful attention to research participants, seeking contrast in the data collected, and addressing results to a diverse audience.

Develop compelling explanations Acknowledge the pro-active character of qualitative research and provide frameworks for understanding its underlying dynamics.

Similarly to qualitative research in general, many authors investigated the possible benefits and constraints of Internet-based surveys. In particular Evans & Mathur (2005), Van Selm & Jankowski (2006) and Wright (2005) report extensive reviews of the field and identify the major strengths and potential weaknesses of online surveys. Recurrent benefits include low resources (cost and time) required, large number or high specificity of potential respondents and ease to reach them, and participant anonymity, which allows addressing critical personal issues more openly. A large body of research compared web surveys with traditional methods such as post mail, telephone or face to face. For instance Aoki & Elasmar (2000) concluded that email surveys are superior to mail surveys with respect to completion time, cost, and response rate, at the expense of more partial and less open-ended questions submitted. Comparatively, Kaplowitz et al. (2004) found no difference in response rates between web-and traditional mail-based surveys, given that a mail notification is sent to targeted respondents in advance. However, response rates has been found to be lower for web surveys than for other methods, due to the effects of sample recruitment base, solicitation mode and number of contacts (Manfreda et al., 2008), as well as population type and follow-up reminders (Shih & Fan, 2008).

As discussed in Malhotra (2008), completion time is a delicate issue. In fact, a low completion time is considered a valuable characteristic strived for by online researchers, however participants who answer surveys very rapidly seem more prone to primacy effect and therefore generate poor quality data. Evans & Mathur suggests best use practices for conducting successful online surveys as well as possible solutions to tackle the potential weaknesses identified. Among these potential weaknesses, issues related to sampling, coverage, nonresponse and measurements are the limitations mostly described in the literature since the early days of mainstream Internet research (Couper, 2000, 2001, Andrews et al., 2003). It should be noted that these limitations are often addressed to qualitative research in general, and not only to Internet-based research. In addition to these limitations, design and implementation issues are yet to be resolved (Vehovar & Manfreda, 2008), as briefly discussed in the next section.

In *Conducting research surveys via e-mail and the web*, Matthias Schonlau and colleagues investigated whether online surveys are as faster, better, cheaper, and easier to conduct than offline surveys, as commonly claimed in the literature. Although the authors agree with the claim of speed at which online

surveys can be deployed, they are more careful about the other assumptions. Concerning the quality of online surveys, coverage and response rates issues are opposed to a lesser social desirability bias, better access to hard-to-reach populations and the absence of coding needed to process open-ended questions. Regarding the cost issue, Schonlau et al. reminds us that the time and monetary costs involved in planning, conducting and analysing online surveys are often underestimated. Finally, despite early research arguing that web-surveys are much more complex technically than paper-based ones, and that the general lack of participant education in web technologies may hinder results (see for instance Dillman et al. (1998)), current bandwidth conditions and technology penetration in the populations targeted by this research allow to assume appropriate response time by the survey system and sufficient knowledge of web page design standards by respondents.

Design considerations

Much research has addressed issues related to Internet survey design, as illustrated by the 42 page bibliography maintained by the *Cross-Cultural Survey Guidelines*[1] (Survey Research Center, 2010). This section does not intend to provide an exhaustive review of this impressive literature, but rather introduces the most salient issues relevant to the survey used as a case study in this work.

It is acknowledged that the many ways web users can access an online survey may alter not only the questionnaire's look-and-feel but also how it functions (Best & Krueger, 2008). More specifically, usability principles are thought to significantly impact both response rate and accessibility, as thoroughly studied by Kaczmirek in his thesis on *human-survey interaction* (Kaczmirek, 2008). Moreover, nonresponse bias can be minimized using appropriate design strategies, related to the survey structure, its length, the presence of progress indicator, the inclusion of advanced visualization and interactive elements, and the format of questions and answers (Vicente & Reis, 2010). Recently, Singh et al. (2009) identified and reviewed the decision points concerning procedural and technical issues undergone by researchers when designing an online survey. Procedural issues include technology choices, sample selection, participation solicitation, response management, and ethics, privacy and security. Technical issues include question design and order, survey appearance, navigation scheme, visual progress indicators, and pilot testing. Additionally, according to the literature review of electronic surveys conducted by Andrews et al., web-based surveys should rely on the following guidelines: 1) Careful analysis of the study population to determine best sampling strategy, 2) Documentation of the survey limitations to establish result validity, 3) Piloting to polish the survey, 4) Establishment of engaging invitation and participant reminder strategy, and 5) Respect of confidentially and privacy of respondents (Andrews et al., 2003). Complementing these guidelines, *The handbook of online and social media research* by Ray Poynter provides specific, practical recommendations for designing online surveys. Most importantly, researchers should bear in mind that such surveys are

[1] CCSG homepage: http://ccsg.isr.umich.edu/

self-completed by participants, which means without interventions from a facilitator. This puts high requirements on the survey in terms of autonomy, clarity, and ease of completion. According to Poynter, the opening of the survey should include a comprehensive yet brief introduction explaining the general purpose of the study, who the authors are, and how the answers will be used. This introduction should also address potential privacy concerns and state the level of anonymity with which answers are treated, and if personally identifiable information is collected from participants. Then, the formulation of each question should be brief and easy to understand and answer. It should also consider how the questions will be rendered in various web-browsers (e.g. large screen versus mobile phone) and read by respondents belonging to various cultures (e.g. left-to-right versus right-to-left). Finally, the closing of the survey should thank participants, possibly ask for additional comments and either close the survey or reroute it to another page (Poynter, 2010). Other design features to consider when setting up online surveys include labelling and visual appearance of rating scales (Toepoel & Dillman, 2011), the choice of survey tool (Bogue & Marra, 2006) and the possible inclusion of multimedia content to the survey (Vicente & Reis, 2010).

Another aspect particularly investigated in the literature concerned with online survey design is the choice between presenting questions in a one-page scrollable format or to divide them into parts. Both approaches present advantages and drawbacks, and the effect of this design choice on response rates, break-off rates, and subjective assessment of the questionnaire are much debated. For instance in Norman et al. (2001), four designs were tested for potentially yielding differences in completion time, revision time, and subjective assessment. The four designs considered were: 1) Long scrollable form (all the questions are displayed on the same page), 2) Semantic sections (questions are grouped by topic and might require scrolling), 3) Page partitioning (questions are grouped in such as way that no scrolling is required), and 4) Single item (each question is presented separately on one screen). Each of the four designs was presented with or without an index on the side of the page for direct access to parts of the survey. Results collected from 140 respondents show that response time does not vary significantly across designs, although the index tends to slow down responses for long form and semantic sections designs. Revision time however varies significantly across designs, according to the presence or absence of the index. Revising items referred to textually takes significantly longer with the index in the page partitioning and the single item versions of the survey. On the contrary, revising items referred to using numbers is significantly faster with the index in the single item design. Overall, Norman et al. found no evidence of significant difference between scrolling and navigating through sections when the survey is navigated through linearly (by answering the questions one at a time without revising the answers). They also suggest that the long scrollable survey design might better support navigating through the questions when revision is needed. In a more recent and similar experiment, Peytchev et al. (2006) suggest that non-response and break-off are similar for both scrolling and paging survey designs, but the latter results in lower response times and prevents omissions when the survey includes conditional questions. Further illustrating the uncertainties in the impact of survey design on response rate, completion time and subjective

evaluation of the questionnaire, Toepoel et al. (2009) presents a case study where increasing the number of items per screen (cases tested: one, four, ten and forty item(s) per screen) significantly increased nonresponse rate (especially among men, the older and the low-educated respondents). Conversely it significantly decreased completion time (especially among women), and significantly lowered subjective evaluation of the survey (especially among men). Answers to the questions themselves were however not impacted by the design. Overall it seems that paging is mostly profitable for long surveys and/or those including conditional questions, as well as for researchers concerned with careful analysis of potential dropouts, as suggested in Vicente & Reis (2010).

As concluded by Vicente & Reis, "*the literature review does not provide a direct answer for the best combination of "general structure, length, disclosure of survey progress, visual presentation, interactivity, and question/response format" to enhance response rates*" (Vicente & Reis, 2010, p. 265). Keeping this comment and the previous considerations in mind, the survey conducted for the present research integrated the design criterion listed below. Furthermore, question formulation in the context of a cross-cultural study, participant related issues such as recruitment, incentive and reward, and data analysis considerations are addressed in subsequent sections.

Survey tool A personalised Google Form was used, as it leaves great flexibility in design while providing a simple and straightforward data collection system.

First page When accessing the survey web page, the title of the survey is displayed in the three available languages, together with a flag representing the language (as depicted in Figure 5.1). Clicking on either of the titles displays the introduction in the desired language as well as the body of the survey.

Length The survey is deliberately short: it includes 20 questions (including demographics), and takes about ten to fifteen minutes to complete.

Design format Since the number of questions is limited (20 including demographics), the survey is presented in a single, scrollable page, where the four sections are clearly identifiable. The introduction to the survey remains at the top of the survey page at all times.

Question types The survey includes a mixture of forced-choice and multiple-choice questions, grid rating scales, and open-ended questions.

Visual appearance The HTML code of the survey is an altered version of the code generated by the Google Form, to fit the study's cross-cultural dimension and to provide a consistent uncluttered look-and-feel. Apart from the language flags, no multimedia elements are present in the page.

Last page After pressing the "submit" button at the bottom of the survey page, respondents are thanked for their participants and encouraged to further spread the word about the survey on a selection of social networks (including Facebook, Twitter, Google+, and LinkedIn).

Figure 5.1: Survey language selection: Clicking on either title displays the survey in the corresponding language.

Language issues

The language challenges faced in this study reminds the issues discussed by Pranee Liamputtong in her chapter about cross-cultural communication and language issues in qualitative research (Liamputtong, 2010). Especially when the study is conducted by neither an "insider" nor a bicultural researcher, challenges emerge in communicating with study participants. In that case, Liamputtong reckons that relying on translators is inevitable although not without consequences on the results. This echoes previous findings about the effect of the translator and her level of engagement in the study (Temple & Young, 2004). Interestingly, Temple & Young note that the dilemmas inherent to cross-cultural qualitative research are applicable to all types of research. Moreover, Liamputtong embraces earlier suggestions by Edwards, who emphasized the importance of considering translators/interpreters as key research informants, and to actively involve them in the study process (Edwards, 1998, Liamputtong, 2010). Regarding the translation process itself, Edwards and Liamputtong argue for using forward and back translation, which is performed in three steps: First, one interpreter translates the material from one language to the other; Second, another interpreter translates the result from the first interpreter back into the original language; Third, the result is compared to the original material and discussed in case of discrepancies. This technique, first proposed in Brislin (1970) seems however more applicable to interview material and longer transcripts. A team-based translation approach has recently been proposed in Harkness (2008) as an alternative to back translation. The *Translation, Review, Adjudication, Pre-testing and Documentation* (TRAPD) is believed to be superior to translation methods relying on individual interpreters, as it takes advantage of the mix of skills and expertise of the team members. TRAPD has been developed and applied to the European Social Survey (ESS, 1999), a cross-European academic tentative to "explain the interactions between Europe's changing institutions and the attitiudes, beliefs and behaviour of its diverse population".

Careful wording of survey questions and answers categories (when relevant) is critical. Hennink points out that appropriate use of language is key to minimize respondent recall bias (inaccurate recall of facts by respondents), instrument bias (unclear questions and/or inappropriate response categories), social desirability bias (respondent's wish to appear socially worthy), and interviewer bias (interviewer's ability to direct respondents toward an an-

swer) (Hennink, 2008). Transnational surveys require much attention if one seek to compare results across the countries in which the study is conducted. After analysing the various linguistics factors to be considered when wording questions in cross-national surveys and reviewing guidelines for easing the translation process, Smith argues that "*researchers should follow the idea of 'more is better'*" (Smith, 2003, p. 89), and suggests that "*researchers must be more careful, invest more effort in instrument development, and include more items in their surveys*" (Smith, 2003, p. 91). Achieving equivalence (interpretive and procedural, as defined in Johnson (1998)) in cross-cultural survey research is indeed a tedious process that requires intervention at all phases of the research. Johnson identifies 19 methods for addressing equivalence during question development, pretesting, data collection and data analysis. He advises researchers to include as many of these methods in their design process.

The survey discussed in this thesis follows the practical guidelines summarized in Smith (2003), at the exception of the discouragement to use hypothetical questions. On this issue previous research showed that "*people rarely produce coherent thoughts on most imagined situations and may not be able to even grasp the state of affairs described in the item*" (Smith, 2003, p. 88). However, it is argued here that the hypothetical situations described in the survey (*imagine that you cannot use your [mobile phone / TV] any more* and *imagine that your home TV set and mobile phone are somehow connected*) are considered to be concepts easy enough to be grasped by the target population, which is highly literate in media and communication technologies. In fact, even though it might not reveal the extent to which this last hypothetical question was understood by all respondents, only two participants (< 1%) expressed difficulties to grasping its meaning.

The survey has been first designed as an English Source Language Questionnaire (Harkness & Schoua-Glusberg, 1998), and pilot tested by university colleagues for question relevance and overall pertinence of the questionnaire. Then, a non-professional translator, native speaker of each target language was approached and asked to translate "directly" (Sechrest et al., 1972) the survey into Danish or Japanese, respectively. The question formulation was discussed with them separately and adjusted according to their recommendations. Due to the simplicity of the themes covered in the questionnaire and of the questions themselves, only few adjustments were applied and no back translation was deemed necessary. The responses collected in each language populated two separate spreadsheets, which eased the initial analysis and translation of the answers. In fact, results from each country were processed individually at first, and were later collapsed for joint scrutiny. The same two translators helped converting the answers from the *other* fields and the open-ended questions back into English.

One notable translation issue emerged from the potentially different understandings of *disgust* for the questions related to expected feelings in case media devices would no longer be accessible. As mentioned in section 2.4, the Danish translation in both contexts of the mobile phone and the television

encompasses the same combination of loathing, abhorrence and rejection. On the other hand the Japanese translation varied for each context, even though the translator assured that the meaning remains the same. Disgust associated with the loss of mobile phone was characterised by the feeling of getting tired, bored, and to loose interest, while in the case of TV, disgust reflected irritation, annoyance. The extent to which such slight translation differences impact the responses from survey respondents is however unknown.

Recruiting participants

The main issues associated with recruitment addressed at online surveys are coverage bias (units of the target population have different probabilities to be included in the sample population, and some might be excluded), sampling bias (only a portion of the target population is represented in the sample) and nonresponse bias (responding participants differ in opinion from nonresponding participants). It has been argued that a population recruited through Internet is inherently biased and that it is virtually impossible to generate a random (probabilistic) sample (Kaye & Johnson, 1999). However if one is interested in or comfortable with a non-probabilistic sample, online technologies offer great advantages for recruitment of cross-cultural populations. In our case, we were especially interested in technology-savvy, male and female Danes and Japanese. Although this population is not representative of the general Danish and Japanese populations, these demographics fit well the general target population of this thesis: early adopters and followers of media and communication technologies.

One approach to recruit participants online is via crowdsourcing. Jeff Howe, author of *Crowdsourcing: How the Power of the Crowd is Driving the Future of Business* (Howe, 2009) first coined this word play combining *crowd* and *outsourcing*, describing "*the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined, generally large group of people in the form of an open call*" (Howe, 2006). Crowdsourcing underlines collective intelligence: it is centred around the assumption that under the right set of conditions, a crowd will outperform the individuals it is made of (Howe, 2009, Surowiecki, 2005). It is argued that crowdsourcing helps connecting businesses with their audiences and consumers, and that the competitive basis of the method encourages workers to generate contributions of quality equal or superior to what would have been achieved through traditional outsourcing. The main advantages of crowdsourcing user studies put forward by Kittur et al. are the large audience (potentially hundreds of participants), the rapidity of responses (down to minutes) and the marginal recruitment costs (Kittur et al., 2008). Nevertheless, the validity and reliability of crowdsourcing is arguably questionable. One of the most obvious criticisms to crowdsourcing is the reliability of results it generates, which is related to the level of honesty that can be expected from online workers (Suri et al., 2011). Even though countermeasures and guidelines have been suggested to prevent or limit dishonest behaviour, reliability remains a critical issue to be dealt with when crowdsourcing jobs or studies (Ipeirotis et al., 2010, Kittur & E.Kraut, 2008, Mason & Watts, 2010, Snow et al., 2008).

Respondents to the cross-cultural survey about media consumption were recruited using a mixture of convenience and snowball sampling through social networks, resulting in a sample being both *recruited* and *unrestricted* (Watt, 1997). To do so we first contacted a selection of colleagues and friends in both countries directly via email. These solicitation emails were formulated in a non-commercial and non-threatening manner (Singh et al., 2009), and were personalised (Heerwegh, 2005). This communication was also an opportunity to maintain professional and/or friendly relationships. These key contacts not only took part in the study but also acted as ambassadors for the survey within their own professional and/or personal networks. For instance university professors advertised for the survey to their students, and friends further spread the word to their own friends and family. This recruitment approach induces self-selection bias toward young and high educated respondents, as reported in other studies (see for instance Brickman Bhutta (2012)). It is however argued that these demographics match the early media technology adopters targeted by this research.

In addition to direct emails, online social networks (SNSs) were used for further recruitment. The simplest approach to invite people to take part in a survey via SNSs is to ask one's direct connections on the network (later referred to as the *seed*) and to suggest that they advertise for the study to their own connections on the network. These newly recruited test participants are in turn asked to invite their own connections upon completion of the survey. By repeating this process for a number s of *waves* it is hoped to attract a sufficiently large fraction of the target population through several connection levels. This chain-referral technique, also referred to as "snowball sampling" (Goodman, 1961, Biernacki & Waldorf, 1981) and illustrated in Figure 5.2, has been widely used by sociologists to recruit hard-to-reach or hidden populations (Browne, 2005, Eland-Goossensen et al., 1997, Faugier & Sargeant, 1997). Even though the population of interest in the present study is neither hard-to-reach nor hidden, snowball sampling is deemed appropriate due to the potentially large audience that could be reached if all participants invites even a fraction of their own connections. Finally, SNS-based chain-referral is conceptually comparable to word of mouth recruitment, which has been proven successful in online studies, as for instance reported in Rodríguez et al. (2006).

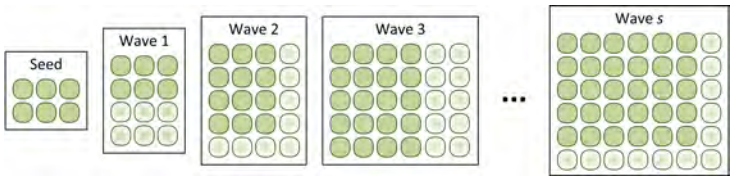


Figure 5.2: Principle of snowball sampling. The sample grows with each wave of participation.

Several limitations to snowball sampling should however be considered when designing such study. The biggest challenge comes from the non-

generalizability of the findings, which is a shared issue among non-probability sampling strategies. Since the test sample is not randomly generated, snowball sampling provides a potentially biased representation of the target population. Another challenge resides in engaging respondents in recruiting the next wave of test participants. Respondents should be motivated not only to take part in the survey, but also to act as the researcher's assistants upon completion of the survey by identifying potential other respondents and suggest them to join in the study as well. We argue here that potential bias can be minimized by adopting the following recruitment principles, arguably applicable not only to snowball sampling, but to any Internet-based recruitment method.

Obtaining a large sample size A large sample minimizes the risk of misrepresenting the target population by reaching more of its units.

Relying on a variety of direct and indirect sources to create the seed Diversity in the seed will spread to the next waves, minimizing the risk of skewing the sample toward a specific sub-population of the target population.

Including influencers and opinion leaders Taking advantage of the large online networks of opinion leaders helps maximizing sample size.

Reaching isolated members of the target population Potential respondents with a small network are harder to reach but should be looked for and included in the sample as they will further minimize the sample bias.

Striving for transparency when communicating with respondents Engaging with participants in a comprehensive and transparent way should ensure a better dissemination of the recruitment among the network of participants.

Two specific social networks were used to reach Danes and Japanese: Facebook and Twitter. Indeed, Facebook[2] is highly popular among both Danes and Japanese, and Twitter[3] is vastly used in Japan. Mixi, one of the three Japanese online social network giants, was also considered for the study, for it is similar to Facebook in terms of functions and use, and it is vastly popular among Japanese[4]. However access to Mixi is limited to owners of Japanese mobile phone contracts, and its interface is available in Japanese only, which makes it rather hard to approach for a non-Japanese speaking living outside the country. It was therefore discarded. In the following the opportunities and issues specific to the two selected platforms are investigated in light of the current survey. The approach followed for the two platforms is similar: posts were published publicly following each platform's formatting standards, encouraging anyone to participate in the survey. Additionally, influencers were asked to further spread the word about the survey using the same platforms. The recruitment strategy adopted in both cases is non-aggressive, for two reasons. First, SNS-based recruitment was not expected to be the prime method to reach the target population, but was considered more as an interesting experiment complementing direct contact and remote recruitment via influencers.

[2]Facebook: www.facebook.com.

[3]Twitter: www.twitter.com.

[4]As of the end of December 2011, Mixi reported its users database to exceed 26.2 million: http://mixi.co.jp/en/about/ (April 7th, 2012).

Second, the limited presence of the author on Facebook and Twitter at the time of the study was expected to constitute a barrier to the success of the study. Overcoming this limitation would have required a substantial investment in strengthening visibility on the two networks in the months leading to the study. As a result, it is hard to know how many responded to Facebook and Twitter recruitment, but it is expected that in the case of this study, it is quite low compared to the number of participants recruited using direct email solicitation and chain referral with influencers.

Facebook

According to the social media statistics portal Socialbakers[5], there were 2.8 million active Danes on Facebook in April 2012, which corresponds to 59.9% of Danes with Internet access. This makes the social network giant an obvious choice of platform for conducting online research among Danes. As a comparison, the 8 million Japanese Facebook users at the time represented a 8% online penetration rate. However Facebook has been booming in Japan in that period: the number of Japanese on Facebook increased by 3.3 million between October 2011 and April 2012. This suggests that most of the Japanese Facebook users at the time were early adopters of media technology. Moreover, 82% of the Japanese Facebook users were between 18 and 44 years old and equally split among gender, which corresponds to the demographics targeted in the present research.

Ethical issues, sampling bias, result reliability and validity are essential factors to be considered when using Facebook as a research platform (Redmond, 2010), even though it has been argued that unbiased sampling is achievable (Gjoka et al., 2011). As discussed earlier, snowball sampling initiated by contacting a selection of direct connections seems an appropriate method to recruit survey participants through Facebook. Because they join spontaneously and independently from material rewards, participants who engage in answering a study posted on a social network are expected to be inherently motivated and therefore relatively honest in their answers. Additionally, contacting reliable and established research colleagues and friends further acting as recruiters is expected to minimise ethical issue and non-response bias as well as generating reliable answers valid for the target population. Finally, given the large population of Danes and Japanese using the platform, it is expected that this method allows reaching a sample representative of early adopters of media technology in both countries.

Another recruitment approach specific to Facebook consists in creating an advertisement that links to the survey. Doing so potentially increases the initial visibility scope of the survey, as it will be seen by people outside the researcher's circle of Facebook connections. Additionally, Facebook ads can be targeted to specific demographics in terms of age, gender, location and interest, which eases the recruitment process when demographics are an issue. If research in this area is still in its infancy, an example of such approach has been described in Tan (2010). Results from this study are promising in terms

[5]Socialbakers: www.socialbakers.com.

of response speed, but falls behind other methods with regard to response rates, and is argued to suffer from sampling bias due to the demographics of Facebook users (essentially, young students being overrepresented). In a study among inactive and ex-Catholics, Brickman Bhutta reports very promising findings with regards to the comparability of survey results collected through Facebook and from traditional census organizations. Although demographic control variables are not conserved across methods, content-oriented questions correlates strongly with results from the 2008 General Social Survey and the 1999 Gallup Poll of Catholics (Brickman Bhutta, 2012). Many factors might explain the differences in Facebook recruitment experienced by Tan and Brickman Bhutta. Table 5.1 compares the two studies in terms of a few design choices and performance at recruiting survey participants.

Table 5.1: Comparison of two surveys conducted through Facebook.

	Tan (2009, 2010)	Brickman Bhutta (2012)
Survey duration	6 days	100 days
Number of responses	59 (39 usable)	4,016 (3,998 usable), 426 after 5 hours, 2,788 after 5 days
Price per response	2$	< 1¢
Facebook use	Facebook ad linking to SurveyMonkey	Contact of friends and administrators of relevant groups
Topic	Learning preferences and use of calculators	Catholic practices and beliefs
Number of questions	12	15
Completion time	NA	12 minutes
Target demographics	Year 11 and 12 mathematics students from Victoria (Australia)	Baptised Roman Catholics in US

Our survey on everyday media use implemented Facebook as an extension of the direct email technique, utilizing the platform for four purposes. Firstly, public posts encouraging people to take part in the survey were created: one "note", which is basically a post longer than the usual status updates, as well as a regular post by the author. Some of the colleagues and friends contacted directly also posted similar posts on their own initiative. Secondly, a few potential participants were recruited directly via Facebook mail. Thirdly, participants who completed the survey had the possibility to "like" the survey, which resulted in a post appearing on their wall. Finally, thank you statements and advertisement of the results (available online) were published as regular posts after the data was analysed.

Twitter

The microblogging platform Twitter has gained popularity extremely fast since its creation in 2006. According to French consumer insight provider Semiocast[6], Japan counted 29.9 million Tweeter accounts by January 1st, 2012 and the country ranked second in terms of activity. Moreover, Japanese is the second most used language on Twitter. In Denmark though, the platform has known very limited success so far, as discussed in Section 2.3. Twitter recruitment in the present study was therefore mostly targeted at Japanese individuals.

Twitter has been mostly researched from a usage point of view. For instance it has been argued that major events such as earthquakes in Japan (Sakaki et al., 2010) and mood surrounding elections in Germany (Tumasjan et al., 2010) or the US (O'Connor et al., 2010) are reliably predicted by analysing tweets due to the real-time nature of Twitter-based communication. Even the stock market seems predictable by analysing Twitter mood (Bollen et al., 2011). Furthermore, Twitter is seen by market researchers as a successful form of electronic word-of-month, useful to branding and spread ideas quickly and to a large audience. Jansen et al. suggests to leverage Twitter's near real time communication paradigm for branding in the *attention economy*[7] (Jansen et al., 2009a,b). Over its few years of existence Twitter has become a large corpus of opinions, emotions, ideas, and an extensive network of individuals with a wish to share information, even though the ties within such network should be considered with precaution, as demonstrated in Huberman et al. (2009). Harnessing this immense information pool allows conducting a wide range of research studies, from building sentiment analysis tools (Pak & Paroubek, 2010) to develop new communication paradigms in higher education (Ebner et al., 2010).

Within the research community, Twitter is used as a tool to reinforce one's authority and peer network (Letierce et al., 2010), and to exchange information during conferences (Weller et al., 2011). Citing articles on Twitter is another common practice among scholars, who use the platform to disseminate their work faster and more dialogically than with traditional methods (Priem & Costello, 2010). Academic literature concerned with the use of Twitter as a source for recruiting study participants and more specifically for online surveys is however lacking. Few resources are available online for researchers interested in conducting surveys via Twitter: tips helping designing and running successful Twitter-based surveys (Miller, 2011), and commercial services supporting the deployment of quick polls or more complex surveys, such as twtpoll[8].

[6] Brazil becomes 2nd country on Twitter, Japan 3rd Netherlands most active country: http://semiocast.com/publications/2012_01_31_Brazil_becomes_2nd_country_on_Twitter_superseds_Japan (April 7th, 2012).

[7] Readers interested in the shift from money-based to attention-based economy could refer to the work by Franck - an English version of Franck's article on *The Economy of Attention* is available at: http://www.heise.de/tp/artikel/5/5567/1.html (April 7th, 2012). See also *The Attention Economy and the Net* (Goldhaber, 1997) and *The Economics of Attention: Style and Substance in the Age of Information* (Lanham, 2006).

[8] twtpoll's homepage: http://twtpoll.com/ (April 7th, 2012).

For the purpose of this study, Twitter is perceived as a word-of-mouth instrument to expand diffusion of the survey recruitment to Japanese individuals. Much like Facebook, Twitter has therefore been used in a non-aggressive way: tweets in each language of the survey were posted by the author a couple of times during the duration of the survey. Moreover, participants who completed the questionnaire were encouraged to tweet about the survey at the click of a button. A selection of Japanese influencers retweeted the original solicitation and/or posted personalised ones. Finally, directions to the results of the survey were posted upon completion of the data analysis.

Analysing the data

From a practical perspective, processing data collected from an online survey is relatively straightforward. Most survey tools allow exporting the results directly into worksheet processors such as Microsoft Excel. At the time of the study, the data submitted to a Google Form was collected into a Google Spreadsheet, updated live as forms were submitted. A first approach to mining the survey data consisted in exporting this data into MS Excel and performing simple frequency analyses of the answers to each questions. Statements from *other* fields and open-ended questions were clustered upon meaning similarity. Graphs were produced to help with a first interpretation of the data, especially when comparing answers by country of origin, gender, and age group.

Then, the data was processed using statistical tools of analysis, to validate (or refute) the conclusions drawn from the frequency analysis and establish significance levels when answers vary according to demographics. A recurrent issue when conducting statistical analysis of survey data is weighting, which supposedly helps compensate sampling, coverage and nonresponse biases. However weighting does not always work, as for example demonstrated in Vaske et al. (2011). After comparing two weighting by population proportions strategies (by a single variable versus multiple variables), Vaske et al. argue that weighting does not compensate for these biases, and that Internet surveys based on convenience sampling are best used in combination with other inquiry methods for limiting bias. In the present study, weighting to compensate for country and gender biases is unnecessary due to the high similarity of sample sizes in each subcategory. Concerning the age group distribution, the survey respondents are found to represent well the demographics characterising the principal segments of interest used in the CAMMP project, which are primary *buzz* users, and to a lower extent *business* and *bling* users, according to the classification described in Wieland & Thaarup (2011).

Finally, the following statistical methods were applied to the data collected, according to the type of data generated by each question. Computations were performed using the statistical environment *R*, for its simplicity to set up and use. Moreover, *R* is freely available and cross-platform.

Fisher's Exact test Used to test categorical data against 2-level independent variables, such as the effect of country of residence on the type of mobile phone owned by respondents. The *R* method is 'fisher . test (x,y)'.

Chi square test Used to test categorical data against independent variables with more than 2 levels, such as the effect of age group on the type of mobile phone owned by respondents. The *R* method is 'chisq.test(x,y)'.

One-sample median test Used to test variation in ordinal data, such as the variation in the frequency at which respondents surf Internet on their mobile phone. The *R* method is 'SIGN.test(x,md)' from the *BSDA* package, where 'md' is the population median for the NULL hypothesis.

Wilcoxon-Mann Whitney test Used to test ordinal data against 2-level independent variables, such as the impact of gender on the frequency at which respondents check their emails while watching TV. The *R* method is 'wilcox.test(x~y)'.

Kruskal Wallis test Used to test ordinal data against independent variables with more than two levels, such as the impact of age group on the interest expressed by respondents in betting via a second screen during sport events. The *R* method is 'kruskal.test(x~y)'.

Concluding remarks about cross-cultural online surveys

Based on the experience conducting an online survey in a cross-cultural setting described in the previous sections, the following conclusions can be drawn on this research method. First regarding the technicalities of such study, it is argued that today's tools reduce dramatically the complexity of setting up, conducting and analysing the data collected from Internet based surveys. In the present case, basic knowledge of web technologies (HTML, CSS, Javascript, and PHP) allowed to generate a fully customizable online questionnaire. The biggest challenge with regard to this concerned cross-browser compatibility, which is arguably one of the most important success factors of online surveys. Potential survey respondents should be allowed to freely use their web browser of preference to access an online survey, unless required by the study conditions.

As expected, language issues are inevitable even in case of short questionnaires, and especially with three languages involved. Additionally in the present case, the lead researcher (myself) had limited proficiency in one of the languages (Danish) and almost no knowledge of the second one (Japanese). Only frequent interactions with the translators involved in creating the regional versions of the survey allowed to make it understandable within limited resources (time, man power and money wise).

As previously argued, direct personalized contact via email seems the most efficient way to initiate a recruitment campaign for online surveys. Additionally, using social networks as a pool of survey respondents appears to be highly beneficial in term of resources allocated to recruitment if the initial seed is sufficiently influential and active in and off the network in order to draw participants in the study. Additionally, the initial seed should be connected to other influencers for the chain referral process to happen over a few recruitment waves, and the researcher(s) initiating the study should

be familiar with and active in the network to engage in, moderate and potentially adjust the recruitment process. Particularly, sending reminders and continuously looking out for recruitment venues ensured a decent sample size.

Overall the online survey used in the context of this research proved to be an efficient research tool for gathering general information about the use of technology by a relatively large number of test subjects. The next sections will discuss methods better suited to smaller samples, studied either in small groups or individually.

5.2 Scenarios

This section investigates how scenarios are included in user studies to support the exploration of user experience with media technology. First, various frameworks devised in the user-centred design literature are presented, before concrete cases where scenarios have been generated and employed in the context of this dissertation are introduced and discussed.

Scenarios in user-centred design

Scenarios and use cases are well-established techniques to explore user experience at an early stage of product development. Scenarios and later use cases are derived from the insight gained from the involvement of the users in the design process. For John Carroll in *Making use*, "*Scenarios are stories–stories about people and their activities*" (Carroll, 2000b, p. 46). The three elements common to all scenarios are:

A setting including the spatio-temporal context and the relative positions of the physical objects involved in the scenario.

Actors the individuals performing in the scenario, according to their own set of goals.

A plot a sequence of actions performed by the actors that might influence the setting or the actions of other actors.

Carroll's above definition of scenarios is echoed in Rogers et al.'s *Interaction design*:

> "*A scenario is an "informal narrative description" (Carroll, 2000a). It describes human activities or tasks in a story that allows exploration or discussion of contexts, needs and requirements.*"
>
> (Rogers et al., 2011, p.374)

Scenario-based user centred activities are popular and often used by designers who wish to involve users in creative exploration, design or test activities. For instance Muller (1999) referenced 25 types of methods directly involving scenarios within usability studies. Scenarios used in ICT projects often focus on the users' interaction with the technology, the situations in which it is used as well as use patterns. Scenarios use the vocabulary and phrasing of the users so they are understood by all stakeholders who are part of the development process. The elaboration of scenarios is often the first step in establishing requirements. Scenarios should be formulated in a concrete and flexible way, adhering with how people create and understand stories (Carroll, 2000b). Then from scenarios a number of use cases are usually identified, focusing on "*a user-system interaction rather than the user's task itself*" (Rogers et al., 2011, p. 379). Even though Rogers et al. also note that scenarios can represent a path through a use case, the following discussions will focus on scenarios as generic tools for investigating users' behaviour within a given context, and as a "*lightweight method for envisioning future use possibilities*" (Rosson & Carroll, 2002, p. 1032).

In the context of designing mobile applications, de Sá & Carriço suggest an explicit framework for composing what they call "complete scenarios", which include three modular concepts: contextual scenarios, scenario transitions and scenario variables. Using this framework, contextually related parameters such as location, movement and posture, workloads, distractions, etc. become explicitly defined in the scenarios (de Sá & Carriço, 2008a).

Many classifications of scenarios have been devised in the UCD literature, among which a selection of overlapping definitions will be introduced in the following paragraphs. A first relevant dimension for categorizing scenarios is provided by Kees Van der Heijden in *Scenarios: The art of strategic conversation* (Van der Heijden, 1996). External scenarios are opposed to internal scenarios (referred to as "strategic narratives" in later editions of the book) according to the following definitions (Van der Heijden, 1996, p. 5):

External scenarios are "*derived from shared and agreed upon mental models of the external world*". They are value-neutral (their emotional load is minimized) and depict possible future developments taking place in the outside world that are "outside our own control".

Internal scenarios "*belong to a person and relate to his/her anticipation of future states of the interactional world*". They represent causal links between action options and a goal, they are normative (some are preferred over others) and they can be interpreted as "*one path through a person's cognitive map*".

In Campbell (1992), scenarios are classified according to their purpose toward a system:

Illustration By communicating how the system works, these scenarios help answer the question "what is it like to use the system?"

Evaluation They are the basis for usability tests, as they exercise the basic tasks users need to perform on the system.

(Re)Design Real or hypothetical, they support functional specification elicitation and focus on how the system will be used.

Testing theories Regardless of task relevance within a particular framework, these scenarios support evaluating HCI theories through "test cases".

Another simple framework for including scenarios in user-centred design work has been proposed in Bødker (2000), which summarizes earlier work on the integration of scenarios in UCD research process. According to Bødker, scenarios are oriented toward the future and are used either to *present and situate solutions*, to *illustrate alternative solutions*, or to *identify potential problems*. Illustrating this position, she considers using scenarios with three specific purposes: 1) for conducting usability tests of prototypes, 2) for investigating possible future designs, and 3) for provoking thoughts and generating ideas for future designs. The latter introduces the concept of plus and minus scenarios, which depict alternatively the positive and negative sides of the system under consideration. An example of problem scenario that illustrates

alternative solutions via a plus-minus approach is given in Mancini et al. (2010). The research team generated two versions of a scenario involving a dieting support system. In one version the actor demonstrated positive traits in his relation with the technology, with food and with other actors, while the other video depicted negative versions of such traits. The two versions were presented to workshop participants, and each video triggered different (sometimes overlapping) discussion topics. Mancini et al. thus argue that presenting both positive and negative versions of technology use enables "control and breadth". Comparable yet different representations limit presentation bias, which would make the audience react to the presentation of the technology rather than to the technology itself. It also triggers discussion on a wider range of topics, as various aspects of the same technology are illustrated.

Additionally, the following five scenario objectives have been described in Quesenbery & Brooks (2010):

Describing a context or situation These scenarios describe "*not only a sequence of events, but they also provide insight into the reasons and motivations for those events*" (p. 9).

Illustrating problems Those illustrate a "*point of pain—a problem that a new product, or a change in design, can fix*" (p. 10).

Launching a design discussion The objective of these scenarios is to "*open up thinking about a design problem [...] or start a discussion*" (p. 12).

Exploring a design concept Those scenarios "*help shape a new design by showing it in action*" (p. 13). This can be done using various multimedia creations, such as videos, storyboards, or verbal narratives.

Describing the impact of a new design Finally, those scenarios "*describe a user experience that doesn't exist yet*" (p. 16).

This thesis relied on videos as a contextualization tool in the usability experiment reported in Section 3.2. More details about how the videos were used in this context are described in Section 6.3. The present section focuses on how scenarios in general have been created and used throughout the project and for specific activities. Apart from videos, multimedia-based scenarios can be based on pictures, as described in Pedell (2004). The author argue that picture scenarios differ from storyboards as they encompass more than the interaction of a user with design suggestions, as storyboards usually do. Instead, picture scenarios integrate the context in which the system is to be used. This type of scenario has been proven efficient at guiding participants (especially non-designers), illustrating actual contexts of use, and eliciting ideas (Pedell, 2004, Pedell & Vetere, 2005).

If one were to follow Rosson & Carroll approach to *Scenario-based design*, the following five types of scenarios would be applied iteratively throughout the development process of a product or service.

Problem scenarios are established in the analysis phase of the design process, either based on field observations or made up entirely. They describe the

current situation of the actors and the system design. They are iterated on in the later stages of the process in a way that eventually the developed system addresses both the positive and negative aspects of the problem scenarios.

Activity scenarios address the goals and constraints of the problem scenarios and suggest ways to turn current practice into new design features. Focus is placed on goals and motivations for the new activities rather than specific aspects of the user interaction.

Information scenarios address users' perception and interpretation of the system by the user; they integrate all aspects of how the task information is organized and delivered to users while using the system. Options for information designs are evaluated though the activity scenarios.

Interaction scenarios go hand in hand with information scenario as they explore concrete techniques for manipulating the system, which helps keeping the technology developed relevant to the activity.

Usability specifications are derived from analysing critical subtasks to which specific (expected and/or desired) usability outcomes have been assigned. These scenarios are then tested with users and results are compared to these outcomes. These scenarios are closely related to use cases as defined previously.

Finally, more complex analyses of scenario typologies have been realised, although less adapted for the purpose of this section. For instance Ducot & Lubben proposed the segmentation of scenarios according to three contrasting axes (descriptive to normative, exploratory to anticipatory, and trend to peripheral) defining 27 types of scenarios each answering a different question (Ducot & Lubben, 1980). Similarly, van Notten et al. established a set of characteristics pertaining to project goal, process design and scenario content, leading to the identification of 14 types of scenarios (van Notten et al., 2003). The following paragraphs focus on scenarios relevant to mobile media, and discuss the ones used in the course of this thesis.

Mobile media scenarios in CAMMP

In their extensive review of *methods for understanding mobile technology use*, Hagen et al. classify scenario-based research methods as part of the *Simulation and Enactment* category, which aims at exploring device use from perspectives that are either not possible via mediated data collection or simply non-existent (Hagen et al., 2006). In the context of the CAMMP project, a variety of such scenarios have been developed by the different work packages in relation to both their own goals and the overall vision of the project. Within the work package interested in *User requirement and validation*, each user study was conducted in the context of a scenario, which has been either specifically constructed to fit the requirements of the study, or considered as relevant by prior research and thus reproduced for contextualizing the evaluation of various aspects of user experience with new media. The following briefly presents the eight scenarios used throughout the relevant user studies reported in this thesis, before Table 5.2 summarizes the types of scenario applied to these studies according

to the definitions by Campbell, Rosson & Carroll and Quesenbery & Brooks identified in the previous paragraphs.

Study #1

- *Setting:* A cafeteria at lunch time, representing a busy public environment
- *Actor(s):* A single user who owned a TV-capable mobile phone
- *Plot:* The actor watches live TV content on the mobile phone.

Study #2

- *Setting:* Not strictly defined, a place common to the actors
- *Actor(s):* A group of friends
- *Plot:* The actors review a selection of movie trailers and agree on one to go watch together at the cinema.

Study #3

- *Setting:* A bus trip
- *Actor(s):* A single user, who own a TV-capable mobile device
- *Plot:* The actor browses through TV channels on the mobile device.

Study #4

- *Setting:* The actor's living room
- *Actor(s):* A single user, who own a video-capable mobile device
- *Plot:* Upon returning home watching video content on the mobile device, the actor "transfers" the content from the mobile device to a home TV set on which to resume watching the video.

Study #5

- Each participant generated individual mini-scenarios based on the recollection of a memory attached to television and mobile phone. The settings, actors and plots thus vary from participant to participant.

Study #6

- Each participant generated individual mini-scenarios based on a set of contextual cards and functions associated with televisions and mobile phones. The settings, actors and plots thus vary from participant to participant and from group to group. More details about the scenarios (or stories) generated during this activity are summarized in Table 3.3 of Section 3.1.

Study #7

- *Setting:* Various environments in the everyday life of the actor
- *Actor(s):* A MiniTV system owner in various social settings
- *Plot:* The actor attending to her daily business and using the system at will.

Table 5.2: Types of scenarios used in the user studies throughout the project.

Study	Campbell (1992)	Rosson & Carroll (2002)	Quesenbery & Brooks (2010)
#1	Illustration	Problem	Describe context
#2	Testing theories	Activity	Launching point for discussion
#3	Evaluation	Usability	Describe context
#4	Evaluation	Interaction	Explore concept
#5	Illustration	Problem	Describe context
#6	Illustration	Problem*	Describe context
#7	Evaluation	Information	Describe impact
#8	Testing theories	Activity	Explore concept

* future problems.

Study #8

- *Setting:* The actor's living room
- *Actor(s):* A single user who owns an Internet-enabled mobile device
- *Plot:* The actor watches live TV programmes and use a second screen application on a mobile device to interact with the programme's content.

Concluding remarks on scenario use

The scenarios developed for the eight studies reported in this thesis (for which scenarios are relevant) have been are a mixture of researcher- and user-generated stories. They cover a wide range of scopes: some focus on very general aspects of user experience with mobile media technology (such as in studies #1 and #7), while others pinpoint details of the user interaction with potential systems (studies #3 and #4). Overall these scenarios enabled the exploration of both *typical* and *critical* use situations (according to Carroll & Rosson (1992), also defined as *trend* and *peripheral* in Ducot & Lubben (1980)). One might argue that the sequence at which they have been applied throughout the project departs from the user-centred design frameworks described previously, for instance in Rosson & Carroll (2002). The authors however recognize the necessity for this framework to remain flexible and open to the apparition of new exploration paths as "*the technology raises new possibilities for action, and people's creative use of the technology in turn creates new requirements for support*" (Rosson & Carroll, 2002, p. 1058). The CAMMP project, and thus the studies conducted in the context of this dissertation, followed a yearly iterative cycle involving work packages with different objectives and perspectives on the overall project vision. Frequent interactions between work packages, internal iterations at a project partner level, and constant technological evolution outside the project lead to the constant questioning

and redefinition of research objectives in adherence with a *requirement-design-evaluation* cycle typical to user-centred technology-based projects.

As a final comment, one should keep in mind that throughout such projects, industrial shifts of interest in specific technologies may alter the expected flow of the iterative UCD cycle. Specific to CAMMP, a visible decline in relevance of DVB-H in Europe occurred mid-project, which required a refocus in the activities of the work packages. This impacted the team in charge of user requirements and validation in a way that the work conducted remained largely conceptual, as illustrated by the scenarios discussed in this section. The final scenarios investigated, related to the use of second screen devices, are highly conceptual, however they pave the way for a close-up analysis of critical aspects of user interaction.

Focusing on the participant-generated scenarios collected in study #6, the following section will investigate how drama workshops centred around challenging situations can be used to link previous experience with media technology to potential future interaction designs.

5.3 Creative exploratory workshop

This section documents part of the work conducted during my six month stay at The University of Tokyo. More precisely it elaborates on the drama-based workshop methodology introduced as the third case study in Fleury (2012). The benefits and pitfalls of theatre-based techniques for exploratory technology workshops are explained and conclusions based on its application to the study of user experience with televisions and mobile phones are drawn.

In general, participatory design workshops are a common way to investigate how a population perceives a technology and what it expects from it. Additionally, investigating technology use through the lenses of performative art has been recently called for by researchers interested in practice-led research (Haseman, 2006) and ubiquitous media (Jacucci et al., 2005). Theatre-based methods are perceived as a promising way of supporting user profiling (Park & Lee, 2009) and the design process, in particular of mobile IT (Seland, 2006) and for gathering requirements, especially with non-tech savvy populations (Newell et al., 2006).

The original idea behind the workshop used as a case study here was to generate concrete scenarios for future use of the two specific communication technologies of interest in this dissertation, namely televisions and mobile phones. With that vision in mind, the early versions of the workshop design borrowed from creative frameworks for eliciting ideas such as Theodor's *Creative Method and Systems* (Theodor, 2010) and Vavoula & Sharples's *Future Technology Workshop* (Vavoula et al., 2002, Vavoula & Sharples, 2007). However after several iterations of study plans designed with the help of university colleagues, the purpose of the workshop was redefined as an exploratory analysis of possible use in challenging contexts made up from a combination of everyday life elements. Three main reasons lead to this redefinition: 1) limited resources to conduct the workshop (planning and conducting the aforementioned workshops require a dedicated team not available for this project), 2) language issues between facilitator and participants (the exercises included in creativity workshop typically rely on specific instructions that need to be conveyed in a timely fashion, which is difficult to achieve when translations issues arise), and 3) uncertainty concerning the appropriateness of the method to the cultural context (for instance some exercises rely on time pressuring participants, which might be perceived improper and thus alter participants' contribution or willingness to contribute). As a result, the approach eventually selected included a mixture of individual self-reflecting and collaborative exercises leading to a group acting performance, more suitable for the research context. The workshop thus became more "performative", a concept introduced in the following paragraphs.

Acting is deeply integrated into people's life, regardless of the nature of acting, whether it being an artistic performance or a part of everyday routine. Until circa 2000 academia regarded acting as primarily a research method in social and health science (Yardley-Matwiejczuk, 1997). More recently, scholars have argued for a better inclusion of inquiry methods inspired by theatre to other research areas. The topic has been extensively scrutinized in the past

decade, especially focusing on the application of performative inquiry in education (Fels, 1999), theatre-based techniques for discussing about technology with older adults (Morgan & Newell, 2007), or closer to our concern in this section: role-play as a user-centred method for designing mobile IT services (Seland, 2010). A common justification for embracing drama-based techniques in such a variety of qualitative studies is the deep understanding of the participants' intimate experience with the object of the research through their embodied emotions. For instance by focusing less on technology and more on the visualization of its use, scholars are more prone to focus on the personal motivations behind user experience. As Gergen & Gergen put it,

> *"in moving toward performance the investigator avoids the mystifying claims of truth, and simultaneously expands the range of communities in which the work can stimulate dialogue."*
>
> (Gergen & Gergen, 2003, p. 580)

According to Muller, it is generally accepted in the literature (although not strictly established) that theatrical methods have the following benefits (Muller, 2003, p. 1060)

- It **builds bridges** between software professionals and users.
- It **enhances communication** through embodiments and contextualized narratives.
- It **engages audiences** (small and large), influencing the usage and design of technology.
- It **increases designers' empathy** for users.
- It **simulates the use of not-yet-developed technology** to explore new possibilities.
- It **results in fuller understanding**, more informed discussions.

In her 2010 PhD thesis, Gry Seland notes that role-play used in design is a multidisciplinary field rooted in theatre studies, social sciences, system development and psychology. She provides an extensive review of drama-based techniques used in the design process of various products, mostly focusing on mobile solutions. She classifies the literature according to the motivation behind the use of role-playing: whether it being understanding users and context of use; exploring, testing and communicating ideas; involving users; enhancing the design process; or other reasons (Seland, 2006, 2010). Finally, Seland adopts the following framework inspired by Buxton (2007), which identifies a set of questions related to various aspects of the play to be asked when designing role-play activities.

Script *What is the level of scripting?* How much improvisation is allowed?

Director *Is there a director or coach, and if so, who?* A professional or a member of the design team?

Actors *Who is doing the acting?* The designers? End users?

Audience *For whom is this piece of theatre?* For the intended users? For the designers?

Setting *Where is the performance conducted?* In situ? In a simulated environment? In a generic space?

Type of performance *Is it a performance or a rehearsal?* Is the acting continuous or can it be interrupted?

Props *What props are used?* And who designed and built them?

Seland's thesis conclusions are threefold: First, she concludes by identifying five important issues to planning and running role-play design workshops with end users: 1) practical issues such as participant recruitment, material prototyping and session recording, 2) challenges in making participant act out, 3) the process of generating ideas, as part of the acting or separately, 4) choice of workshop resources (including material and spatial setting location), and 5) the various roles (e.g. actor, conductor) during the session. Second, Seland elaborates on Muller's findings concerning the strengths and limitations of such role play workshops as a system development method from the developer's perspective. Those findings are summarized in the following.

Advantages

Role-play workshops are useful for

- Developing ideas
- Enhancing active user involvement
- Helping developers understand context of use

Especially in the early design phase of a project, theatre-based participatory techniques are useful for

- Fast idea creation
- Creating focus in the project
- Establishing a good group process

Drawbacks

However researchers should be aware that these methods

- Lack a system overview perspective
- Provide only the user's perspective
- Present an idealized version of reality

Third, the role of the facilitators in such workshops is identified as helping participants developing, rehearsing and acting out their plays, as well as facilitating the idea generation process.

Other scholars have argued for the benefits of including role playing in participatory design workshops occurring at early stages of the design process. In particular a group of Finnish HCI researchers have generated a large body of work regarding the use of drama and dramaturgy in user-centred

design processes. For instance Mehto et al. (2006) introduces state-of-the-art theories, methods, as well as case studies. In their work, Mehto et al. have identified seven types of drama-based workshops, detailed as follows.

Play-back theatre A personal story is told then acted out by actors, who embody the key elements of the story.

Drama workshop A set of collaborative activities (discussions, improvisations, physical exercises, etc.) allows exploring a specific issue through the participants experiences and emotions.

Forum-theatre A conflictual situation is acted out then discussed and key moments are re-enacted to try solutions.

Dramaturgical reading A story is read out loud in a dramatic fashion, emphasizing key emotions to encourage discussion.

Design improvisation A collection of techniques to explore a theme and underlying emotions and life tensions.

Informance What is known about users are role-played by actors, bringing forward specific elements of the base material.

Bodystorming Design questions are extracted from observations and related scenarios are acted out in situ.

Examples of play-back theatre and drama workshops are reported in Tiitta et al. (2005). Tiitta et al. explored the issues associated with retirement using a mixture of user-centred product concept design (UCPCD) and drama-based methods. The methodological lessons learned during the experiment encourage the use of drama-based techniques in addition to more traditional approaches for several reasons. Firstly, the emotional and social dimensions of interaction are more thoroughly investigated; they provide users a way to explore their experience from a different viewpoint, which can be beneficial especially in early design phases. Last but not least, the ease of conducting drama-based workshops was put forward.

An example of using dramaturgical reading is reported in Kantola et al. (2007). In this study, Kantola et al. developed dynamic personas to support designers in gaining deep insights on their target users. The authors argue that the approach was successful at bringing designers closer to the audience they work for, focusing on personal emotions and situations otherwise omitted in e.g. interviews (see also Kankainen et al. (2005) for another illustration of reaching users' personal and emotionally loaded experiences). Additionally the method was proven good at releasing designers from a sometimes restrictive product-oriented approach. Finally it was argued that dramaturgical reading is a method easy to teach to and apply by design students.

Also referred to as "experience prototyping" or "prototyping in context", bodystorming usually takes three forms: situated prototype testing, simulated prototype testing, or in situ scenario enacting (Schleicher et al., 2010).

Additionally, Oulasvirta et al. identified the following three issues to be considered when setting up bodystorming activities. Firstly, the environment was considered very important, and in situ performances were preferred to simulations. Secondly, acting out required costly preparations and caused frustration with participants not used to the techniques. Finally, including participants' stories in the design questions was appreciated but not considered essential (Oulasvirta et al., 2003).

One critique addressed to these techniques is their tendency to emphasize some aspects of ethnographic data instead of questioning them. For instance, a troupe enacting a scene depicting the use of a tool dedicated to mobile workers might put forward some critical aspects of the user interaction with the tool, but fail to address the rationale for using the tool in this particular context. However as Mehto et al. argue, "*the different dramaturgical and performative forms bring up elements that would otherwise go unnoticed*" (Mehto et al., 2006, p. 985). Additionally, Svanaes & Seland suggest to ask the following questions to evaluate the objectivity, reliability, validity and transferability of role-play workshops (Svanaes & Seland, 2004, p. 485).

- Objectivity: *To what extent do the scenarios and ideas originate from the users, and not from the facilitators or developers?*
- Reliability: *Are the scenarios accurate in their description of the situations being studied?*
- (Internal) Validity: *Are the scenarios describing the important aspects of the situations with respect to the purpose of the workshop?*
- Transferability: *Are the scenarios typical for the situations being studied, i.e. can the conclusions drawn from analyzing the scenarios be generalized?*

Acting out scenarios about televisions and mobile phones

The four-hour long keitai / tv drama workshop conducted in Japan and reported as the last case study in Section 3.1 and in Fleury (2012) included the set of exercises described in the following paragraphs. As introduced at the beginning of the section, the sequence of exercises deviated from the original intended purpose of generating ideas for future media systems via highly creative activities, and instead adopted an approach inspired by Vavoula & Sharples's future technology workshops and Tiitta et al.'s drama workshops. This approach relied less on creativity and more on reflection and expression, and instead of navigating through time as in the future technology workshops, here participants explored an altered version of current reality.

Icebreaker: mixing up purposes

- *Objective:* Setting up participants' creative mindset.
- *Expected outcome:* 12 (illogical) scenarios mixing TV and keitai functions from which new ideas may emerge.
- *Duration:* 00:20.

In order to get the participants in a creative and playful mood, they first took part in an icebreaking group exercise. All participants wrote down a simple sentence about television or mobile phone following the structure

> "I <do something with the device>, to <purpose of doing it>"

Half of the participants were asked to create such sentence related to TV, and the other half to mobile phones. Two examples were provided to help participants. The examples for TV related sentences were 1) *I turn up the volume of the TV to better hear the news*, and 2) *I connect my computer to the TV to watch YouTube videos*; The examples for the mobile phone related sentences were 1) *I launch the Facebook app on my iPhone to update my status*, and 2) *I check the weather on my phone before I go out*. The paper sheets on which participants wrote their sentence was then cut at the coma, and the second parts redistributed so each participant would get the ending of a sentence corresponding to the device they did not write about. Each participant then read out loud the newly created sentence, and very briefly tried to argue for its possible meaning. The principle of this exercise borrows its concept from the *exquisite corpse* game, which consists in collaboratively generating a sentence (or a drawing) without being aware of the contribution by other players. In the case of word-based games, a number of players sequentially write down words, either following an established rule (such as the structure name-verb-adjective-noun), or knowing only the contribution of the previous player.

The following are examples of such created sentences by workshop participants: "*I connect my laptop to the TV to change my mood*" (participants 1 and 8); "*I change channel to 8, to separate a little bit from business mail*" (participants 3 and 10); "*I turn on my television if I think live video streaming sites such as NICONICO DŌGA*[9] *don't look interesting to ask when the workshop starts*" (participants 5 and 12). Not only this short (20 minutes) exercise helped initiating the workshop in a fun atmosphere for participants, it also established the premise for following exercises, which relied on creating unusual connections between mundane technological and contextual elements.

Individual exercise 1: Personal attachment with TV and keitai

- *Objective:* Participants reflect on importance of TV and keitai in their everyday life.
- *Expected outcome:* 12 personal evaluations of TV and keitai, illustrated by adjectives and list of preferred functions.
- *Duration:* 00:30.

Then, the first individual exercise inquired participants about their personal attachment to televisions and mobile phones, respectively. For each device, participants were asked to 1) indicate on a range of emotions which

[9] ニコニコ動画 (Nico Nico Douga) is a popular Japanese video sharing website, which differs from other platforms by displaying viewer comments directly as an overlay of the video, synced to a specific time: http://www.nicovideo.jp/ (May 2nd, 2012).

ones would likely apply to them in case they didn't have the device any longer, 2) write down on cards up to three functions of the device they consider essential, and 3) select among a list of 36 adjectives those which best describe the device according to them.

First, the emotions to choose from were based on Ekman's basic emotions, although slightly modified to better fit the context of the question. As illustrated in Figure 5.3, it included depictions[10] of *anger*, *sadness*, *surprise*, *joy*, and a *neutral* face. As in the figure, the name of the emotion was deliberately omitted when presented to participants; the emotions were thus carried solely by their visual representation.

Figure 5.3: The range of emotions to express reaction to potential loss of TV and keitai.

Then, participants were asked to write down up to three functions for each device that they deemed essential for it to fulfil. By answering this after having thought about the possible loss of the device, it is expected to extract what participants would miss from the device if it was no longer available, which is arguably at least a good approximation of what matters most to them.

Finally, the list of adjectives consisted of 18 pairs of common bi-polar descriptors of objects based on various characteristics including appearance, condition and size. The complete list of adjective pairs is reproduced in Table 5.3. They were selected for their appropriateness at describing either functional, conditional or emotional dimensions, and included some degree of redundancy.

Individual exercise 2: Mini-stories generation

- *Objective:* Generating one scenario per participant involving the functions selected in the previous exercise together with random environmental elements to solve a problem.
- *Expected outcome:* 12 mini scenarios involving personal favourite functions of devices combined with a place, social setting, and mood to solve a problem.
- *Duration:* 00:30.

[10] The faces depicting the emotions were generated with the Grimace SDK, "a free Flash-based web component which displays emotions through facial expressions of a comic-like face": http://grimace-project.net/ (April 26th, 2012). For further details about the grimace project, one could read Spindler's thesis (Spindler, 2009), available from the project's website.

Table 5.3: The 18 pairs of adjectives used to describe mobile phones and TVs.

Active	Passive	Attractive	Repulsive
Exciting	Boring	Convenient	Inconvenient
Shared	Personal	Cheap	Expensive
Private	Public	Loud	Quiet
Hot	Cold	Big	Small
Cute	Ugly	Silly	Smart
New	Old	Modern	Traditional
Difficult	Easy	Hardworking	Lazy
Polite	Rude	Safe	Dangerous

In the second individual exercise, participants integrated the functions they previously identified for both devices into illustrated mini-stories. They were provided with a deck of cards representing common contextual elements, which they should include in their stories. These cards contained a title and a corresponding illustration depicting one of the following components of everyday life situations. A set of such cards is depicted in Figure 5.4.

A problem *lost, forgot keys, exhausted, stuck, late, heavy snowfall, no money, fire, sick*

A location / transportation mode *kitchen, boat, street, concert, train, metro, bus, car, bicycle, train station, airplane, museum, elevator, café, bar, supermarket, restaurant, bedroom, living room, office, meeting room, classroom, library, shopping center, stadium, hotel, elevator*

A social environment *colleagues, best friend, alone, group of friends, family, pet, sister / brother, strangers, boy-/girlfriend, spouse*

A mood *joy, fear, disgust, surprise, anger, sadness*

The purpose of randomly setting up the scene for participants was to provoke them into imagining using familiar technology in slightly surreal setups. According to Sato & Salvador, the fact of changing the situation for a product "*helps the researcher understand the social limits of the new products*" (Sato & Salvador, 1999, p. 40). We further argue that by involving more than one technology in the process, the participants/actors explore potential solutions for overcoming these limits by including either deviant uses of the original technology or by combining existing ones. To illustrate their stories participants had at their disposal a drawing notebook each, pens of various types and colours, scissors, and empty cards for potentially adding functions.

Collective exercises: Mini-play creation and group performance

- *Objective:* Collaborative reflection on the scenarios generated in the previous exercise and generation of a common scenario .
- *Expected outcome:* 4 detailed scenarios involving television and keitai functions enacted by the groups.
- *Duration:* 01:00.

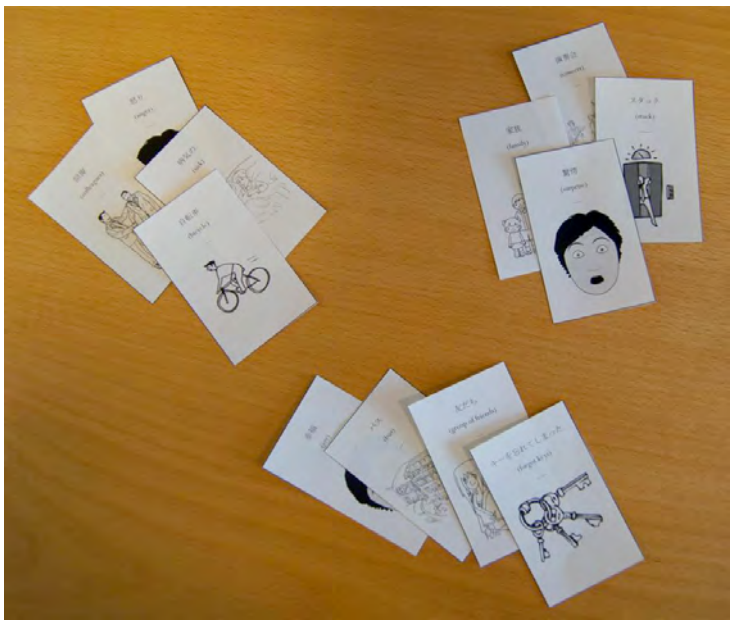


Figure 5.4: Context cards distributed to participants to build their mini-stories on.

After a 20 minutes break during which participants relaxed and chatted, random groups were formed and all thus changed seats. Participants moved their table according to the group formations. The first group activity consisted in a "show and tell" exercise, during which each participant showed the story created individually and explain it to the other two group members. Each story would be discussed briefly. Then the group members collaborated to create a common story inspired by the three individual ones. Participants could discard or add elements to the story, but they were encouraged to keep as many of the technological functions as they could.

Finally, the room was rearranged and a space was created for a scene, on which each group acted out their mini-play, each lasting about five minutes. All participants took part in the plays, with various level of participation. The four plays included a mixture of tragic and comic elements, and were all performed in a joyful atmosphere for the audience composed of the other groups and facilitators.

Setup and facilitator role

The room where the workshop took place is a regular studio of the University of Tokyo's *Fukutake Hall*, which otherwise hosts offices, studios, laboratories, and an amphitheatre. The room is configurable in various setups, thanks to movable wall panels and equipment. Two video cameras mounted on tripods were used to record the workshop, one focusing on a specific (randomly chosen) table, and the other providing an overview of the room. One of the cameras was moved at the end of the workshop to record the mini plays. In

addition to the video recordings, pictures were taken by facilitators, documenting the exercises and capturing overviews of the activities.

While the participants created and illustrated their stories (individually and in groups), three facilitators went from table to table to discuss with them, encouraging the creative process while being careful not to influence it, and taking pictures of the works in progress.

After the workshop, a small party was organized in a restaurant nearby the university, to which all participants and facilitators were invited.

Validating the approach

In order to evaluate the workshop, Svanaes & Seland's questions related to 1) objectivity, 2) reliability, 3) (internal) validity, and 4) transferability are answered.

1. *To what extent do the scenarios and ideas originate from the users, and not from the facilitators of developers?*

   In the keitai / tv workshop, the facilitators provided the framework for staging functions generated by participants into their own mini-stories, which were later revisited in groups. In this case, even if the environment is thus set by the researchers, participants are free to generate ideas within the research framework and to establish any connection between their ideas and the elements of the environment. This follows a typical exploratory approach in which participants generate ideas within a context set by the research team.

2. *Are the scenarios accurate in their description of the situations being studied?*

   The aim of the workshop was to challenge mundane practices with media technology by making them happen in slightly surreal environments, made up of a combination of realistic elements. The depiction of the scenes illustrated in the mini-stories and acted out in the plays are precise as they all included a location, a social surrounding, an issue, a mood, and a sequence of actions carried out within this environment.

3. *Are the scenarios describing the important aspects of the situations with respect to the purpose of the workshop?*

   By exploring alternative scenarios for converging media technology, the individual and collective stories built during the workshop put forward the functions that really matter for participants with regard to mobile phones and televisions.

4. *Are the scenarios typical for the situations being studied, i.e. can the conclusions drawn from analyzing the scenarios be generalized?*

   Despite a certain degree of surrealism in their settings, the core message conveyed by the individual mini-stories and the four scenarios produced in groups are generalizable to the same extent qualitative data resulting from a relatively small sample can be generalized. As commonly recommended with such studies, the results described in Section 3.1

should be used as a basis for further investigations. This could be done for instance by designing and implementing prototypes to elaborate on the user interaction involved in the functions put forward by the scenarios.

Overall, the mixture of personal and creative exploration employed in the TV / keitai workshop was successful for engaging participants in the conceptual phase of the design process of media technology. All participants engaged in the playful activities with an open and creative attitude which lead to fruitful reflection and the generation of ideas. Vavoula & Sharples's future technology workshops and Tiitta et al.'s drama workshops proved useful for designing such a workshop, and Svanaes & Seland's evaluation framework helped keeping the workshop focused on its objectives.

5.4 Participant-generated drawings

This section is based on (Fleury et al., 2011b, Fleury, 2012). It examines how drawings can tackle the methodological challenge of allowing test subjects to express personal matters in an easy way, in a timely fashion, and using a relatively large sample size. The type of personal stories collected and the level of intimacy user experience researchers can access through drawings will be exemplified through the application of the method to a specific research agenda, namely investigating the relationship between users of televisions and mobile phones and the devices. The study related in this paper took place partly during my stay at the University of Tokyo as part of my doctoral study, and partly in Denmark. The socio-historical approach to media studies taught at TODAI encouraged me to investigate technology-free user study tools. Moreover the cultural and linguistic gap experienced during the stay provided an excellent opportunity to try non-verbal user experience investigation methods. This section will also reflect on these cross-cultural challenges.

Drawing as a research method

Drawings and sketches have been part of humans' communication tools palette since their early evolutionary stage. Whether it is for visualizing specific ideas, expressing artistic inspiration, supporting learning process, or ensuring durable memory, drawings are used almost everywhere. In fact when learning how to express themselves, children rely on drawings very early, prior to writing. In our first years of life, we learn to use drawings as a communication mediator. At the same time, we gradually includes writing in the drawings, enhancing the clarity of the ideas we express (Anning & Ring, 2004). The important role drawings play in human development of communication skills explains the vast academic literature available related to children's drawings and their interpretation.

Apart from children studies, it has been argued that simple drawings can help convey complex ideas, especially in the business world. For instance in *The back of the napkin*, Dan Roam demonstrates that drawings help clarifying ideas, expressing these ideas rapidly without the need for complex technology, and sharing them openly, which encourages discussions. It is further argued that "*the value of visual information lies [...] during the action of drawing*" (Mills, 2010, p. iii), that is during the creation process of the image rather than in the image itself. Mills considers drawing as a visual conversation, for which the performance itself is crucial to make sense of the message conveyed. In design, drawings are widely used in order to illustrate and explore scenarios and ideas (like children do) via an iterative process of constant reinterpretation of sketches, even though the inherent ambiguity of sketches may lead to communication failures among design team members (Stacey et al., 1999). Additionally, storyboards are considered efficient and powerful storytelling tools for illustrating a succession of events (Sova & Sova, 2006). As a result of the success with which drawings convey ideas, a large number of educational software tools have been developed to help students learning not only scientific disciplines such as maths (LaViola & Zeleznik, 2007) and

physics (Cheema & Jr., 2012), but also foreign languages (Taele & Hammond, 2009), and of course drawing itself (Dixon et al., 2010).

Exploring people's life, opinions and thoughts through drawing seems however less popular, except in psychology and the medical field in general, as exemplified in the work by Guillemin. Recently, ethnographers have been using drawings to discuss medical conditions with patients, these conditions including systemic lupus erythematosus (Nowicka-Sauer, 2007), heart diseases (Reynolds et al., 2007), and various types of pain experienced by children (Kortesluoma et al., 2008). While exploring how people understand illness and express their perception of it, Guillemin demonstrated that drawings can indeed generate a broad and in-depth perspective on the study at hand. She agrees with Mills in saying that studying the drawing produced alone is not enough, but should be complemented by the analysis of the knowledge built by the drawer while creating the drawing (Guillemin, 2004). Additionally, she notes that a drawing is a snapshot of how the drawer understands a subject at the specific time of the drawing. She reckons the limitations of this visual expression tool and argues that drawings should be used as a complement of additional research methods.

Guillemin's findings are corroborated by Kearney & Hyle who identified the following benefits and drawbacks of using drawings as a research method for investigating the emotional effects of change in an educational institution (Kearney & Hyle, 2004).

1. Drawings reveal emotional aspects that would not be covered in word based communication.
2. Participants focus on the key aspect of their story.
3. Drawings need to be complemented by participant explanation.
4. Response to the drawing task varies according to personal and situational characteristic that may be hard to control.
5. The lack of boundaries associated with drawing alleviates participants freedom of expression.
6. Likewise, researcher-imposed structure determines interpretation of drawings.
7. Drawings is suitable for data triangulation when used in complement to other research tools.

Furthermore, considering drawings as a support for focus groups involving children, Yuen presented evidence that drawings had the following positive effects on the study outcome (Yuen, 2004).

8. Drawing helped create a relaxed and comfortable atmosphere, and released the pressure to answer immediately.
9. It enhanced the communication between the researcher and the children by providing further insight on the children's perspective on the topic

discussed, as well as offering children the possibility to express more personal experiences.

10. It allowed better identification of groupthink and gave each idea expressed an equal chance for consideration.

It should also be reminded that drawings can be culturally reflective. In a study comparing children drawings in Japan and the United States, Voy et al. discovered that when drawing people, Japanese children tend to include more details and represent humans larger but with fewer smiles than their American counterpart. These differences are explained by cultural clues of how children are raised in both societies. (Voy et al., 2001)

A limitation to the method, which is common to all qualitative methods, is a matter of validity, bound to interpretation. When someone (the drawer) communicates an idea through a drawing to somebody else (the viewer), the idea goes through various levels of interpretation, which may alter the original meaning thought of by the drawer. First, mental images are hard to draw due to their high level of abstraction, their tendency to get easily disturbed, and their dimensionless nature (Arnheim, 1969). Second, the drawer verbalization and viewer interpretation are prone to inaccuracies potentially leading to confusion. However this critique applies to any visual- and verbal-based exchanges between an author and an audience. Rather than viewing this as an issue, Guillemin suggests considering the drawings as one of the many ways to perceive the study subject.

Another issue raised in Mair & Kierans's critique of the "draw and write" technique is to establish the difference between the description of the phenomena under scrutiny and the phenomena itself. It is argued in Mair & Kierans (2007) that what is reported by participants through their illustrations might not reflect their behaviour. It might instead be a reflection of their intention, or simply the effect of social desirability bias. While they foresee no specific solution to this representation problem, Mair & Kierans suggest to refrain from considering the data as immediately intelligible or representing more than they actually do, and instead considering the data "*worthy of investigation in their own terms*" (Mair & Kierans, 2007, p. 135).

Discussion

The following presents methodology-related discussion topics that emerged during the evaluation of the drawings collected through the two studies presented in Section 3.1.

Personal and emotional matters

It seems that drawing makes it easy to express personal matters. In both Japan and Denmark, intimate stories were depicted. It is argued that these stories would take longer to collect through verbal interviews, as the act of drawing provides both a personal sphere (centred around the paper sheet) to reflect within, as well as time to think and organize one's thoughts.

It is further argued that drawing provides an opportunity for reflecting on one's behaviour, which opens for further discussions with the drawer. For instance both Japanese and Danish participants realized that they were sometimes using two phones at the same time and that could be considered strange.

Interpretation issues

In general Danish drawings were more ambiguous and harder to interpret on their own than the Japanese ones. For instance it was easy to determine whether a Japanese memory was associated with positive, negative or neutral feelings. On the contrary drawings collected in Denmark were unclear about the emotional load they carry and could only be guessed, calling for further discussion with the authors.

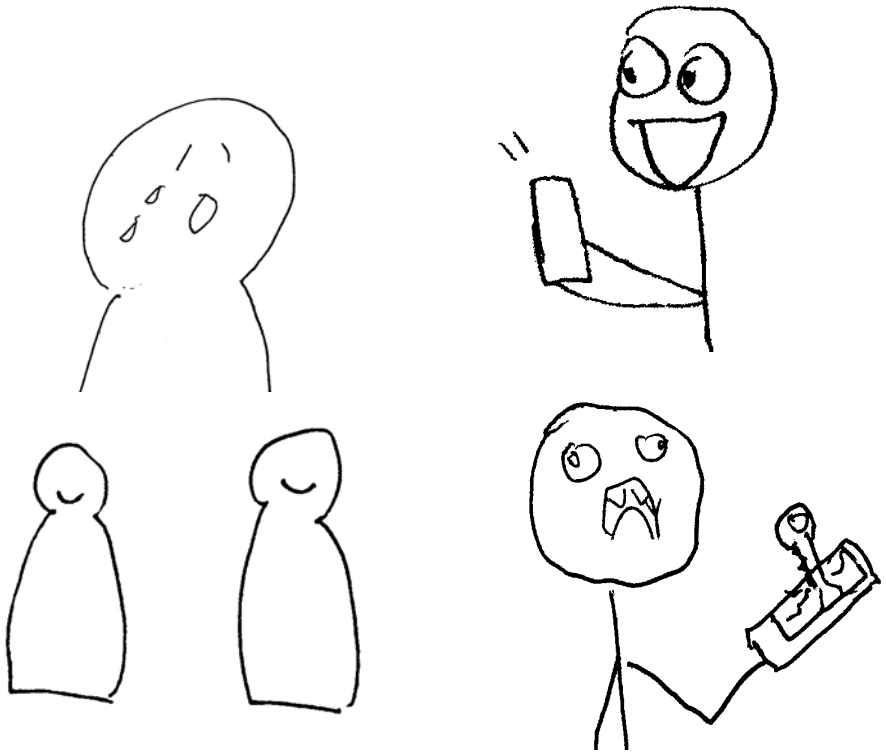
Despite the evidence established by Ekman of universal characteristics for recognising the six basic emotions, when it comes to expressing those emotions via line drawings, cultural filters seem to apply. In our specific case of technology related memories, the need to charge the drawing with an emotional load seemed pretty low in Denmark compared to Japan. Ambiguous drawings mostly focused on technical arrangements, and did not involve people, the facial attributes of whom are usually indicators of emotion. Therefore without further explanations provided by the authors of the drawings, the memories could be interpreted only superficially from their visible descriptive characteristics, leaving out the invisible underlying valence associated with the memory. Thankfully most drawings were accompanied by textual information which helped clarify some cases of ambiguous emotional load. Details of drawings displaying easy to interpret emotions thanks to clear facial features are provided in Figure 5.5, while Figure 5.6 illustrates two ambiguous drawings with regard to the emotion associated with the memory.

Environmental factors should also be considered when asking people to remember a remarkable event related to a specific device. Some participants in both Japan and Denmark expressed their difficulty to think about such a memory related to mobile phones. In fact they considered the device to be so present in their everyday life that finding an extraordinary event linked to it was hard.

Finally, the state of immediate national affairs tend to be reflected in the drawings, depending on the nature and implications of the ongoing events taking place at the time of the study. For instance it was clear that the mindsets of Japanese participants were greatly occupied by the tragic natural disaster that had happened only a few weeks before the study.

Acquaintance among participants

Even though test users should work on their own to produce the drawings, the presence of colleagues, friends or strangers around them might influence their productivity and the level of attention they put into details. However, the drawings collected during the experiments in Japan and Denmark indi-



(a) Japan. (b) Denmark.

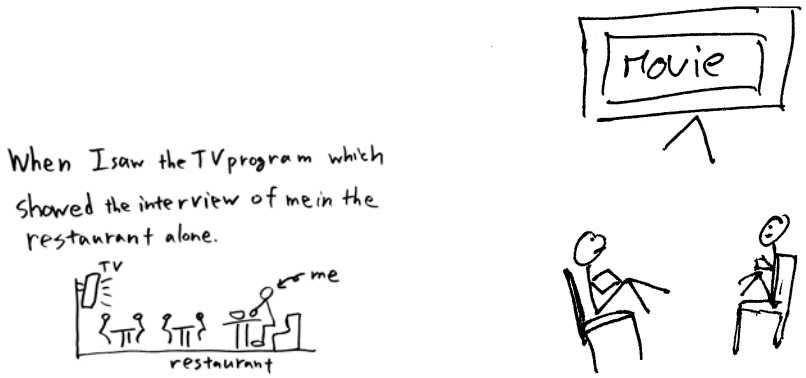
Figure 5.5: Details of drawings with obvious emotional loads depicted by Japanese (a) and Danish (b) participants.

cate no influence of the level of acquaintance among subjects on the output. It could even be argued that both familiar and unfamiliar social surroundings may positively influence how people perform during such activity. In a familiar social setting, one might want to produce something to impress or amuse friends, and when surrounded by strangers, one might want to appear assiduous. Nevertheless, consistency bias may occur in case of participants exchanging heavily during the study.

Conclusion

To the extent of the knowledge acquired while conducting the study and during the evaluation process, drawing seems to provide qualitative insights on the user experience with technology. The following statements have been verified and summarize the findings of the experiment so far:

- Drawing helps create a relaxed and comfortable atmosphere in which test participants are willing to express personal matters.
- The absence of boundaries in drawings further encourages participants to reveal personal aspects of their life.



(a) *When I saw the TV program which showed the interview of me in the restaurant alone.* (Male, 33 - Japan).

(b) *Movie* (Male, 23 - Denmark).

Figure 5.6: Japanese (a) and Danish (b) examples of ambiguous drawings with regard to the emotion carried by the illustration.

- Responses are influenced by the experimental setup.
- Drawings should be used in triangulation with other research methods.

These findings however need to be further investigated, for instance in terms of social desirability bias, combined with additional user experience evaluations as suggested in the literature and compared to other inquiry methods in order to assess the performance of drawings as a useful HCI research tool.

This section concludes the presentation of conceptual methods employed in the course of the present thesis. The next chapter will follow a similar approach to study the prototype based methods used to validate hypotheses and findings.

Final draft

CHAPTER 6

PROTOTYPE-BASED METHODS

6.1 Remote SMS prompting

In this section, we address experience sampling as a study method for evaluating mobile media consumption of Norwegian owners of the MiniTV mobile TV service. The main findings from this study concerning media usage have been discussed in Section 3.2 and partially published in Pedersen et al. (2011). They will therefore not be discussed here. Instead, the main focus of this section is on the methodology; especially the many challenges undergone during the experiments will be scrutinized to derive useful recommendations hopefully helping future researchers avoid the pitfalls we experienced. The campaign indeed suffered from technical problems and communication issues with test participants, leading to a lower than expected response rate and the premature interruption of the study at half the intended period.

Remote experience sampling

The purpose of experience sampling (ES), as defined by Larson & Csikszentmihalyi is to record feelings, actions and momentary thoughts of people in their normal everyday life, striving towards ecological validity (Larson & Csikszentmihalyi, 1983). In the context of this dissertation, ES is employed to explore mobile television use by Norwegian owners of MiniTV. Citing Consolvo & Walker (2003), Cherubini & Oliver defines ES as an ecologically valid research method that "*consists of randomly or semi-randomly sampling the user experience, usually by sending a message to the participant and asking him/her to answer a short questionnaire on a mobile device right at the moment when a relevant event is produced*" (Cherubini & Oliver, 2009, p. 5). ES can be used in a variety of test scenarios, from investigating user experience with specific mobile applications, to conduct quick usability evaluations in mobile contexts, or to capture non-phone related experiences (Lew, 2008). In addition

to multiple choice and short open questions, study participants can be asked to submit audio recordings, pictures or video clips (Lew, 2009). One of the advantages of the method put forward by ES enthusiasts is its independence from data retrieval or reconstruction, contrary to recall-based self-report procedures such as diaries and cultural probes (as defined in Gaver et al. (1999)). Instead it minimizes cognitive bias by querying respondents about situations as they occur. Naturally, the validity of ES relies on the assumption that respondents have access to information of relevance and actually want to report it (Larson & Csikszentmihalyi, 1983).

ES has been employed in a large number of studies, as reviewed for instance in Barrett & Barrett (2001), Scollon et al. (2003) and Cherubini & Oliver (2009). In particular, the advent of smartphones has given rise to a number of frameworks and platforms for ES, such as MyExperience or the Unwire Mobile Survey tool, further described in the following paragraphs (see also specific applications in Consolvo & Walker (2003) and Lew (2009)). In order to help the design of ES studies, Christensen et al. listed the following steps to follow (Christensen et al., 2003).

1. Deciding whether ES is needed, which is dictated by the desire to capture episodic information about a phenomenon taking place in an uncontrolled environment, and that the participant is willing to report.
2. Determine the resources available, in terms of a strong research team, the possibility to remunerate test participants, and to implement the desired tool.
3. Setting the sampling parameters such as duration, frequency and trigger.
4. Choosing software and equipment, according to the study requirements.
5. Considering a security strategy to deal with lost or stolen equipment.
6. Implementing the study, in four parts: 1) configuration and piloting of devices, 2) documentation for researchers (instruction manual, logs, incident reports) and for participants (consent forms, information sheets and contact sheets, employer sheets), 3) participant issues (recruitment, constant motivation throughout the study, compliance with study protocol), and 4) maintenance of equipment and battery issues .
7. Dealing with data issues, by preventing loss and cleaning the dataset.

Finally, Väätäjä & Roto emphasize the critical aspect of questionnaire design, as it needs to fit the requirements inherent to mobile devices and contexts. The challenges to be tackled include the small size screen, data entry and interaction style, the mobile context, and the implementation of the questionnaire. The authors thus provide a list of sensible guidelines to address these issues, as briefly mentioned below.

- Minimize completion time
- Minimize questionnaire length and cognitive load required
- Aim at one question per screen
- When using scales, carefully consider number of steps (5 seems most appropriate)
- Avoid zooming
- Make selection of options easy
- Consider paging versus scrolling (scrolling preferred on touch-based devices)

In the following the issues of timing and frequency of the prompts, the temporal validity of answers submitted, as well as the motivation of participants, are examined in the case of the MiniTV study.

Prompts timing

Prompting (or sampling) can occur either at random (signal contingent), at regular scheduled intervals (interval contingent), or in response to events of interest (event contingent). Adjustable levels of prompting can be used to present questions in a fixed or random order (Larson & Csikszentmihalyi, 1983). In Consolvo & Walker (2003) it is cautioned that scheduled and event-based sampling might introduce cognitive bias (for the latter, especially if the events are triggered by the participant). To address this issue, Cherubini & Oliver (2009) propose a refined ES method (rESM) for use with cell phones. It automates the collection of data that can be captured from the cell phone (e.g. automatic picture taking) and is triggered by objective events (e.g. the user making a phone call). Similarly, the MyExperience[1] open source project by Froehlich et al. (2007) allows participants to submit photos, audio recordings or rating scales. As the use of mobile TV happens independently of cell phone usage, and that the MiniTV service runs on a dedicated device, MyExperience or rESM do not seem suitable for this study. Random sampling seems therefore most appropriate – of course within a suitable time window during the day (e.g. 08.00-20.00) in order not to disturb respondents unnecessarily. The duration of the entire survey was planned to be up to two months. Consolvo & Walker also identified issues related to the delivery and design of questions to be included in the survey. For instance, should the questions be submitted to participants in a text or audio format? Should they be presented in a fixed or random order? Should they be attributed weights or be equally distributed? Should there be branching in the question sequence depending on the answers from participants? Answers to those questions vary from study to study, depending on the goal of the experiment, the number and type of questions to be asked, the target population, and the technical tools used to conduct the study.

Temporal validity

The temporal validity of prompting should also be considered. When prompting via an asynchronous communication mean such as SMS there is no guarantee that respondents answer right away (even though this is highly desirable). In Barrett & Barrett (2001) participants were randomly cued for 10 sec-

[1] MyExperience project website: http://myexperience.sourceforge.net (May 19th, 2012).

onds to record their experiences using handheld devices. After this cue, the participants had 60 seconds to respond. If missed, they were cued again after 5 minutes. If missed again, the cue was recorded as missed. In Fischer et al. (2010) the effect of content and time of delivery on receptivity to mobile interruptions is measured via experience sampling. Here, 50% of the prompting messages were answered within 6.21 minutes of reception, 76.1% within 40 minutes and 90% within two hours. At a general level, a 30-minute response window is suggested as an arbitrary cutoff in Scollon et al. (2003) – where it is argued that with greater time lag, memory bias can have an unfortunate impact on answers.

Prompts frequency

The amount of daily and total prompts sent to participants in ES studies is always to be carefully considered. Similar to the timing, this is a tradeoff between validity, expected outcome and motivation. An aggressive sampling strategy may result in participants opting-out of the study, or the results reflecting default bias, with respondents answering the default choice due to fatigue and/or frustration caused by the high prompting frequency. According to available ES literature, prompting frequency should be inversely proportional to the overall study duration and the time it takes to fill in the questionnaire (Hektner et al., 2007, p. 42). For instance in Fischer et al. (2010) 11 participants were prompted approximately 6 times a day within a 10-hour time window over a period of 10 working days. And in Consolvo & Walker (2003), users' information needs were investigated with 31 participants prompted 10 times a day within a 12-hour time window over a period of 7 days. Finally in Meschtscherjakov (2011) 20 participants received 7 daily prompts containing 4 questions each, between 09:00 and 20:00 during a period of 7 days. In these setups the response rates were 68%, 80%, and 94% respectively. In Consolvo & Walker's study, the two main reasons why respondents did not reply all prompts were inconvenient situations when being prompted (such as during a meeting) and not noticing the prompt.

Respondent incentives

Motivating respondents to take part in such longitudinal study and maintaining their level of motivation throughout the study is of crucial importance to the overall outcome of the experiment. Financial compensation is typically used when trying to motivate people to take part in ES activities. As an example, participants in the survey described in Consolvo & Walker (2003) were offered 50$ for participating (and returning equipment) and an additional 1$ for every completed questionnaire. Determining an appropriate amount of compensation is critical: A too low reward may not attract enough participants, while a too high reward may attract participants who are not intrinsically motivated to participate. As argued in Scollon et al. (2003) a better approach may be to assure that respondents understand the importance of the study. The task of maintaining motivation throughout the entire survey period can be approached in a number of ways. In addition to offering incentives, another way is to limit the burden that respondents feel by participating in the survey.

Recruitment and prompting scheme for the MiniTV study

Data collection during the MniTV study occurred during three phases: 1) recruitment and pre-screening questionnaire, 2) daily prompting of user behaviour in situ, and 3) post-study questionnaire. The recruitment strategy consisted in contacting respondents of an ongoing survey on MiniTV and asking if they would take part in an additional study about their everyday use of the service. Participants were informed that this additional study would be ongoing for a longer period of time and consist of several prompts a day on their mobile phones. This resulted in a total of 17 participants who agreed to carry out the whole longitudinal study. All participants were pre-screened to determine their background, demographic properties and media habits.

A combination of material and intellectual incentives served the purpose of motivating potential participants to enter the study. In addition to entering a lottery to win tickets to popular TV shows, respondents were explained how by participating they have the opportunity to shape the future of mobile television. Finally, respondents who completed all surveys (ie. an initial recruitment survey, the ES prompts and a post-test survey) qualified for participating in a final draw for a mobile TV receiver. In order to keep respondents motivated throughout the study, the questions were designed to take no longer than two minutes to complete, as recommended in Consolvo & Walker (2003).

Then, the actual longitudinal study took place. The issues related to question delivery and design identified by Consolvo & Walker were addressed as follows. Two of the twelve questions selected for the study were delivered daily (including during weekends) to all participants in a written form (an SMS containing a link to the question and choices or fields to answer), following a predetermined distribution scheme according to which each question was asked every 6 days, and thus on different days of the week. Additionally, the prompts occurred at random time during the day, between 08:00 and 20:00. Given the nature of the question (not time contingent) and in order to account for possible situations in which participants might be unable to answer immediately (such as during a meeting), no cutoff time for answers was decided upon. At the end of the study, all participants filled in a final questionnaire, inquiring their general perception of MiniTV.

Survey platform

For the prompting phase, the mobile survey platform developed by Unwire[2] was used. A server sends out text messages to participants containing a link to a short online questionnaire, designed to fit on mobile device screens. Participants click on the link and fill out the survey using the built-in web browser of their cell phone. Answer are then stored in a database. Among other functions, the platform ensures optimal formatting of the forms, depending on the type of the mobile phone used, and records the users' ID

[2]Description of Unwire's Mobile Survey tool: http://www.unwire.com/products/mobile-messaging/mobile-survey (May 19th, 2012).

through URL encoded ID numbers. Thus, it is possible to keep track of individual participants' responses without depending on technologies such as cookies. The platform includes a web-based administrator interface, allowing experimenters to design the prompts, define when and to whom to send the SMSs, track and record the responses and compile various forms of brief summaries presented graphically. The full data sets can be downloaded and imported into e.g. Excel or a statistical package for analysis. Unfortunately at the time of the study the platform did not support conditional prompting schemes, which led to redesigning some of the questions originally envisioned.

Results

Out of the 17 participants who entered the study, 10 actually completed it. Four participants asked to be removed from the list, and three others answered none of the prompts sent during the sampling period. Additionally, five of the respondents completing the study replied to less than 10% of the prompts. Eventually the five remaining participants are accounted for in the following. Furthermore, Figure 6.1 shows that only two participants (#6 and #13) replied to more than half the prompts.

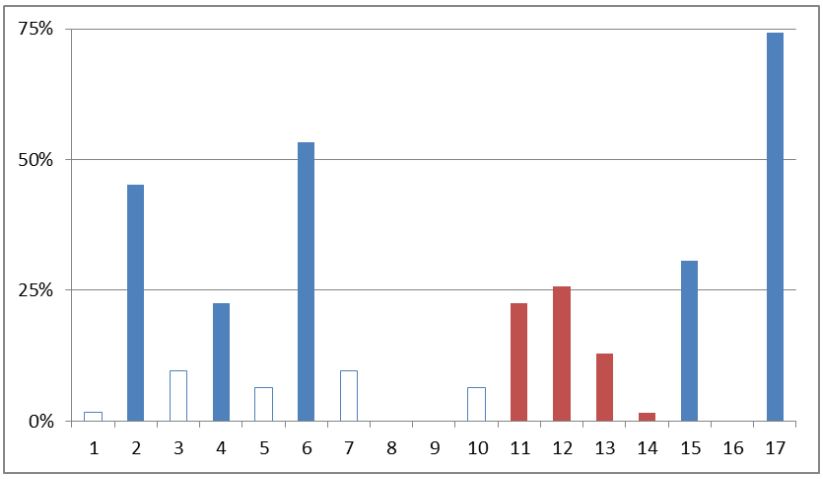


Figure 6.1: Response rate per participant during the MiniTV sampling period. Participants 11 to 14 quit the study on their own request, while participants 1, 3, 5, 7-10, 14 and 16 were discarded for too low answer rates.

Over the 31 days of the study, two daily SMS-based prompts were sent to each of the participants actively involved in the study at the time, totalling 970 questionnaires sent in total (of which the SMS platform successfully sent 943, or 97%). From these, 200 were returned completed, which equals a 21% response rate. However considering only the five participants who completed the entire study, the 312 prompts successfully sent generated 140 replies, which corresponds to a 45% response rate for the most active participants. As illustrated in Figure 6.2, after an initial period of one week, the number of

daily answers received from these five participants stabilized around 4 (out of 10 potential). The gap visible at the end of the first week corresponds to a technical problem leading to the double number of planned prompts being sent for one day and none the following. The figure also shows that overall the five participants who completed the entire study are representative of the original sample of 17 test subjects in terms of response distribution (Pearson product-moment correlation coefficient $r = 0.85$).

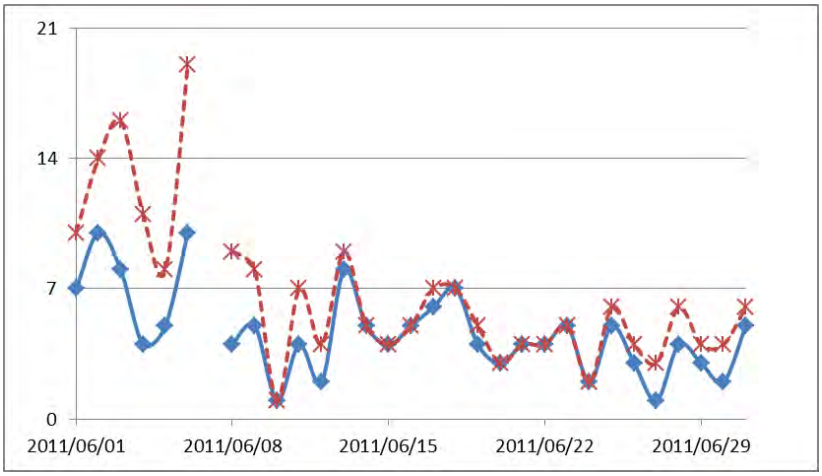


Figure 6.2: Distribution of responses received from participants over the study period. Plain line: 5 most active participants; dotted line: 17 participants who started the study.

When looking at response times, the fastest answer was received a mere 51 seconds after the prompt had been sent, while the longest one took 17 days, 18 hours and 27 minutes to be submitted. The median response time is 01 hour and 43 minutes, far from the 30 minutes cutoff recommended by Scollon et al., let alone the 2 minutes recommended by Hektner et al.. Nevertheless as described in Figure 6.3, the response times observed with the 5 core participants are very representative of the original sample of 17 participants (Pearson product-moment correlation coefficient $r = 1.00$).

In addition, Figure 6.4 shows that response times vary greatly according to the time of the day the prompts are sent. For instance prompts sent between 09:00 and 11:00 were answered within 25 minutes in average, while those sent in the 14:00-15:00 and 18:00-19:00 time ranges were replied to more than 13 hours later in average.

Discussion

Table 6.1 summarizes the MiniTV study's prompting strategy and resulting response rate, compared to the studies conducted by Consolvo & Walker, Fischer et al. and Meschtscherjakov.

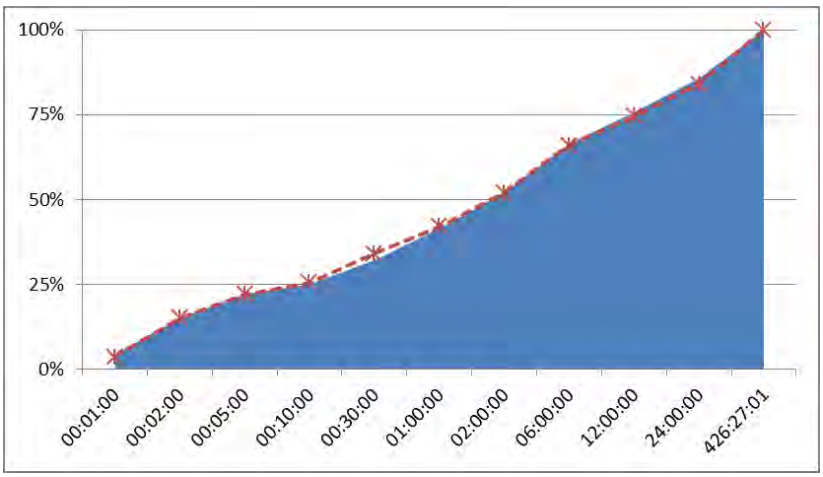


Figure 6.3: Distribution of the response times, ranging from less than 1 minutes to more than 17 days. Plain area: 5 participants; dotted line: original 17 participant sample.

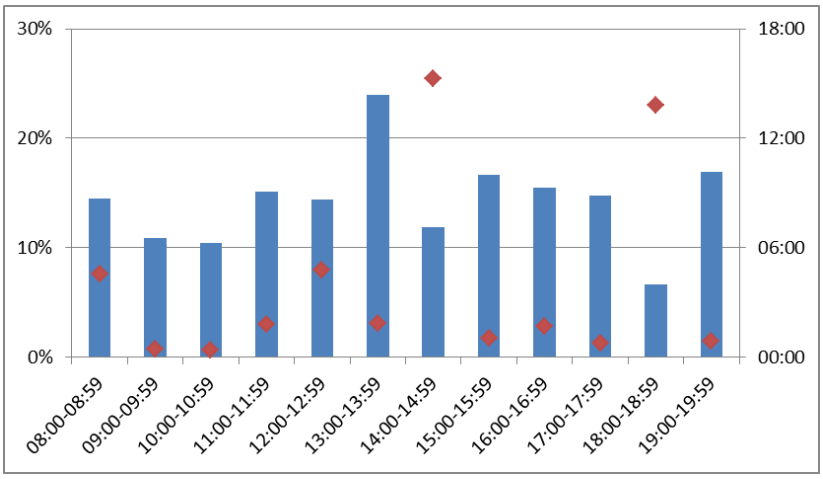


Figure 6.4: Response rates per prompting times (blue bars, left axis), and associated median response times in hours (red diamonds, right axis).

Looking at the results it is evident that both the number of respondents and response rates are lower than could be expected from those reported in the literature. Several reasons might explain this. Most notably, the recruitment process suffered from a number of problems. Due to technical issues, there was a very long period (more than two months) between the respondents agreed to participate and the ES actually started. Therefore, some respondents might have forgotten they agreed to participate, or have changed their mind during this period. Furthermore, the ES was intended as a direct continuation of the survey from which participants were contacted, and this link was clearly broken because of the delay. Additionally, the research team

Table 6.1: Comparison of prompting strategies and observed response rates.

	Consolvo & Walker (2003)	Fischer et al. (2010)	Meschtscher-jakov (2011)	MiniTV (2011)
Participants	31	11	20	5
Duration	7 days	10 days	7 days	31 days
Prompt trigger	Time (random)	Time (scheduled)	Time (scheduled)	Time (random)
Daily prompts	10	6	7	2
Prompting window	12 hours 09:00 to 21:00*	10 hours (chosen by test subjects)	11 hours 09:00 to 20:00**	12 hours 08:00 to 20:00
Incentive	50$ + 1$ per answer	NA	25 €	Multiple lotteries
Response rate	80%	68%	94%	45%

* 00:00-12:00 for one participant working the night shift.
** 10:00-21:00 for the weekend.

communicated with study participants through a number of intermediaries (including translators), which is expected to have hindered the whole communication process. Another issue related to communication was uncovered when some of the participants requested to quit the survey. It seems that some participants were not well aware of the longitudinal nature of the study and the fact that they were to be prompted twice a day. Some respondents reported that this was too many daily prompts, and some were also frustrated with the high amount of similar prompts (each prompt was repeated once weekly). This is surprising when comparing to previous studies but is understandable if participants are not well aware of how the study is conducted. Despite explicit mentions of the setup in the recruitment email and during the pre-test questionnaire, such information apparently was communicated poorly to at least some participants.

Other explanations of the low number of responses are technical in nature. First, on the 6th day of the study, a software problem led to an excessive number of prompts being sent, which might have annoyed the respondents. After this incident, the response rate dropped to about half of that prior to that problem. Second, some participants also experienced problems with their phones and had to copy the links from their phones to a regular browser in order to answer the questionnaire. This alone is expected to account for a large part of the low response rate of the participants who experienced this problem.

Furthermore, the incentive for participating was several draws of ticket for popular shows and a final draw for a MiniTV terminal. Compared to those used in comparable studies (as illustrated in Table 6.1), this is clearly lower.

As a final conclusion, we stress the importance of the recruitment process and for ES researchers to engage in an explicit, direct and repeated communication with the test respondents, as these appear to be deciding factors for their willingness to continue to participate and respond to an ES test. The next section investigates in situ evaluation offering more control over the study, through task-based interviews with early adopters of media technology.

6.2 Situated task-based semi-structured interviews

At early design stages, user experience research methods such as experience sampling (discussed in the previous section), and Wizard-of-Oz (discussed in Section 6.4) have been found suitable to evaluate ubiquitous technology (Consolvo et al., 2007). Even though these methods can also be applied in such case, when the system is fully functional and available on the market for the masses to buy and use, other inquiry techniques seem more appropriate to evaluate user opinion. This section discusses the study of a mobile TV system evaluated using a mixture of semi-structured interviews, subjective assessment and contextual inquiry. The results from such study have been discussed in Section 3.2 and partially published in Fleury et al. (2009).

Among the numerous user research methods available in the UX researcher toolkit, interviewing is one of the most popular ways of inquiring test subjects about their opinion. An interview can however take many forms, according for instance to its purpose and target population, the location in which it is conducted, if it involves prototypes, and how structured it is. Patton (1990) considers the extent to which the questions are predetermined to identify three types of interviews: *informal conversational interviews*, *general interviews guide approach*, and *standardized open-ended interviews*. While informal conversations rely solely on improvisation and the free emergence of topics during the interview, the latter two approaches follow a more or less strict framework to cover a number of relevant topics identified prior to the interview. At the beginning of a general interview guide approach, the interviewer introduces a number of topics, which are to be discussed in no specific order. This is the approach followed during the expert interviews referred to earlier in this dissertation. The case study presented in this section adopted the third approach, which "*consists of a set of questions carefully worded and arranged with the intention of taking each respondent through the same sequence and asking each respondent the same questions with essentially the same words*" (Patton, 1990, p. 280).

Traditionally interviews are conducted prior or after evaluating a system. Instead, this section explores interviews during which interviewees experience a product in a typical context of use, under the guidance of a facilitator-interviewer who instructs participants to perform a sequence of tasks with a product. Similarly to the combined walkthrough technique developed in Partala & Kangaskorte (2009), the interviewer asks questions related to various predetermined topics as the interviewee manipulates the product, and adapts the discussion according to the answers collected. No recall or interpretation is required from participants, the input from whom is spontaneous and little biased.

When it comes to capturing how users perceive interactive systems, subjective assessment "*gives the evaluator information about how the users feel about using the software being evaluated. This should be distinguished from: how well they perform with the software (effectiveness) [and] how efficiently*

they work with the software (efficiency)" (as summarized by Usability Net[3]). Numerous standardized tools have been developed for this purpose since the mid-1990s in the form of questionnaires to be filled in by test participants after or while trying out a product or service. Some of these questionnaires are designed for evaluating computer systems in general, such as SUMI, SUS, CSUQ, and USE (Kirakowski & Corbett, 1993, Brooke, 1996, Lewis, 1995, Lund, 2001), while others focus on specific applications such as WAMMI for websites (Kirakowski & Cierlik, 1998) or SASSI for speech system interfaces (Hone & Graham, 2001), and others such as QUIS (Chin et al., 1988, Harper & Norman, 1993) target the quality of interaction with software[4]. Although we recognize the power of these methods in generating standardized, generalizable answers to critical usability issues of interactive systems, these questionnaires are at the same time too generic in scope to be applied without modification to the mobile TV application of this study, and too focused on usability metrics for the purpose of this experiment. Our objective was instead to collect a mixture of qualitative statements about first impression with the service, and quantitative data regarding a number of topics specific to the mobile TV experience. Thus the method discussed in the following paragraphs, although inspired by the aforementioned tools, takes the form of a more exploratory questionnaire, better suited for the discussion style of the interview.

As discussed in introduction to this chapter, choosing to perform situated usability evaluations depends on the desired tradeoff between ecological validity and test control. The case study presented in this section is a market available mobile TV solution, for which ecological validity can be achieved in various real life environments, as reviewed in Section 1.1. Among the possible environments public transportation and public spaces such as cafés and restaurants were carefully considered when designing the study. Due to the lack of national network infrastructure, only local testbeds could be used for this study, as for instance in Sørensen & Nicolajsen (2010). For practical reasons a non-moving test environment is easier to set up and eventually a restaurant during lunch time was chosen for this experiment.

In summary, the three characteristics of the interviews described in this section can be summarized as follows.

Situated Conducting the experiment in a real environment increases ecological validity.

Task-based All participants experience the same aspects of the prototype, which allows systematic data collection and comparison.

Semi-structured The combination of carefully designed questions and open discussion helps covering a wide range of relevant topics in a timely fashion.

[3]Subjective assessment from Usability Net: http://www.usabilitynet.org/tools/subjective.htm (May 28th, 2012).

[4]See also the list of user interface questionnaires and a web-based system to administer them maintained by Gary Perlman: http://hcibib.org/perlman/question.html (May 28th, 2012).

In situ evaluation of mobile broadcast TV

The evaluation took place in one of the canteen areas at Aalborg University, between morning and early afternoon (roughly between 10.30 and 13.30). At that time the area is quite busy with people walking by between offices, and having lunch or small meetings at the tables available. All participants were interviewed for approximately 30 minutes each. The interviews were individual, which gave control and flexibility to the interviewer, who could not only easily address the topics identified as relevant prior to the study, but also further explore topics of concern for each participant.

Technical setup

The tasks performed by participants were carried out on Nokia N77 phones, receiving a DVB-H signal from a local broadcast setup, as depicted in Figure 6.5.

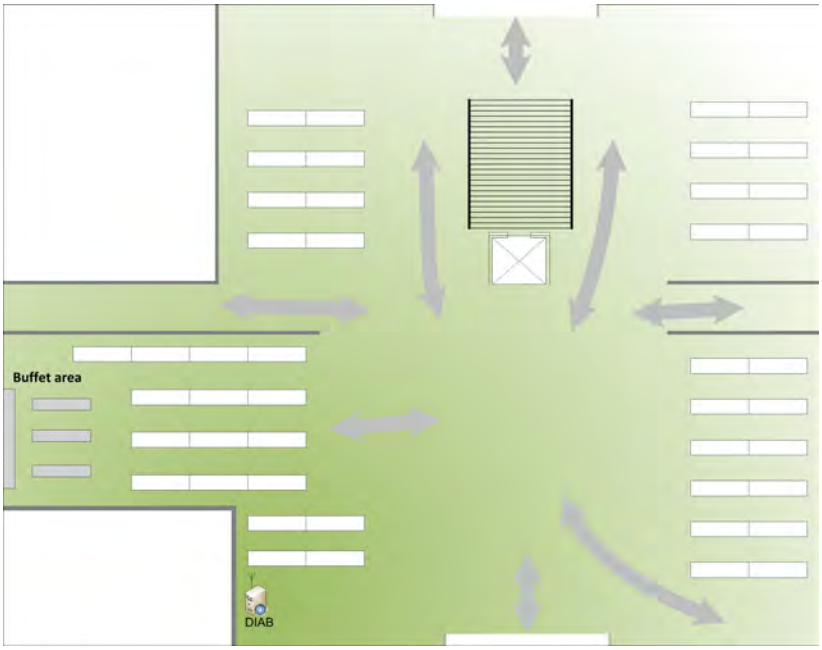


Figure 6.5: Diagram of the canteen as test area. White rectangles: tables; Green gradient: approximate DVB-H coverage of the area; Grey arrow: usual flow of people within the area.

In order to transmit the DVB-H signal, a transportable testbed called DVB-H in a box (DIAB, illustrated in Figure 6.6), was developed by another partner of the CAMMP project. DIAB is a miniature version of the campus-wide testbed used in Sørensen & Nicolajsen (2010) and described in more details in Hammershøj et al. (2009). It is based on open source software combined with applications developed in-house and enables service delivery over DVB-H broadcast and WiFi data link. Its main advantage is transportability: a local

testbed can be deployed in minutes offering very good coverage within a 20 meters radius around the station. The version used for the present study supported up to four live TV channels captured from the available DVB-T signal, which was transcoded into DVB-H and rebroadcast so any DVB-H enabled equipment in DIAB's vicinity could receive the signal.

Figure 6.6: Elements of the DIAB transportable DVB-H testbed.

Test script

The facilitators used the same test script with all 26 participants, reusing the same wording of questions and following the same sequence of topics, directed by the tasks to be performed with the system. The script (reproduced in the following) covered usage expectation, first impression, and user experience issues with the mobile TV system. The examples provided in parenthesis are here to stimulate participants in case they could not answer on their own, and were thus not systematically uttered by the facilitator. The type of question (open-ended or yes/no) are provided in square brackets as [OE] and [YN], respectively. Participants were encouraged to voice any comment or ask any question they might have concerning the service at any time, and between each question short discussions often took place.

1. Welcome the participant.
2. Introduce the facilitator and the project:
   CAMMP is a platform project funded by the Danish Advanced Technology Foundation. It aims at converging 3G mobile technologies with Internet, digital TV and radio and investigating the potential of this new infrastructure in which traditional media are combined with user-generated content. The project has been running for almost 1 year now, and be running for another 3 years with the participation of Danish research institutions as well as private companies.
3. Ask the participant about consumption expectations:
   a) *Where could you imagine that you typically would use a mobile device for watching mobile TV?* (e.g. at home, in the bus, during breaks at school/work) [OE]
   b) *When could you imagine that you would do this?* (e.g. in the morning, during lunch, in the evening) [OE]
   c) *Why would you do this? - what would be your main motivation cause?* (e.g. getting up-to-date with news, watching entertainment to kill time) [OE]
   d) *What would you typically consume?* (e.g. news, entertainment, documentaries) [OE]
4. Present task 1 to the participant
   a) *Did you ever operate a Nokia Smartphone before?* [YN]
   b) *Do you know how to start the media player?* [YN]
   c) *Please try to do so.*

   Take notes while the participant completes the task.
5. Present task 2 to the participant
   a) *Please try to surf the available TV channels on the device – just take your time.*

   Take notes while the participant completes the task.
6. Ask the participant about user experience related aspects:
   a) *What is your first opinion about the TV service (not the phone)?* [OE]
   b) *How did you experience switching between the available channels?* [OE]
   c) *How did you experience the screen size?* [OE]
   d) *How did you experience the resolution?* [OE]
   e) *How did you experience the sound quality?* [OE]
7. Present task 3 to the participant
   a) *Please tune in to DR Update (channel 1) and watch two news stories. Please also pay attention to the news ticker in the bottom of the screen.*

   Take notes while the participant completes the task.

8. Ask the participant about the news stories:
   a) *What were the news stories about?* [OE]
   b) *What did the news ticker say?* [OE]
   c) *Was the news ticker easy enough to read?* [YN]
9. Ask the participant about social aspects of mobile media consumption:
   a) *How did it feel to consume media in a public context?* [OE]
   b) *How did you feel about other people being able to listen in and see the content on the mobile device?* [OE]
   c) *If you were among people you know, could you imagine watching mobile TV?* [YN]
   d) *If so would you rather a) share your media experience with others in your vicinity? or b) to some sense isolate yourself?*
   e) *Would this be different if you were among people you do not know?* [OE]
10. Ask the participant about any other comment/question.
11. Give food voucher to the participant and thank the participant for participating.

Analysing results

As illustrated in Figure 6.7, the statements collected from the 26 participants were categorized by semantic similarity to extract the trends summarized in Section 3.2. This step is critical for comparing results between participants with objectivity. The semi-structure approach supports this by generating not only focused and comparable data for the specific topics covered in the test script, but also individual and personal opinions about those topics and other ones emerging along the discussion with participants. Answer categories are thus easy to identify due to the specificity of the questions asked, yet the possible further elaborations from participants allow finer understanding the tone of the answers and potentially open for additional issues to be discovered. For instance the long delays experience when switching channel proved to be a major drawback hampering the user experience. As a result, this issue was selected to be further explored at a later phase in the project, as discussed in Section 3.2. Furthermore, examples of unplanned topics that recurrently emerged throughout the discussions include cost and audio/video synchronization issues, which were also further explored by other project partners (Windekilde & Falch, 2009) or during other test iterations (as discussed for instance in Section 3.3).

In conclusion, combining contextual inquiry, task-based subjective assessment and semi-structured interviews to evaluate a fully developed mobile TV service is argued to be a powerful, cost-effective, and ecologically valid testing approach. Hypotheses concerning usage expectations and a number of user experience issues were confirmed, and new topics of relevance for further exploration were identified. Especially the situated aspect of the interview is expected to provide a solid basis for validating the findings concerning the

Figure 6.7: Colour-coding the answers is the first and possibly most important step of the data analysis process.

context of use. Nevertheless, as discussed in the introduction of this chapter it has been argued that simulating contexts in a laboratory can also generate valid and generalizable findings. Investigating this, the next two sections step out of the field and deal with user evaluations conducted in lab-settings.

6.3 Lab-based and simulated environment usability evaluation

As mentioned in introduction to this chapter, the ongoing debate between pro-field and pro-lab usability researchers concerning when a test environment can be simulated in a laboratory leaves room for more empirical comparison. The advent of *in-sitro* evaluation techniques seem to offer optimal tradeoffs between ecological validity and experiment control. This section addresses the issues related to simulating realistic environments in a controlled usability lab, and provides a perspective on lab-simulated environments through an experiment conducted in a classic laboratory and a simulated environment. The case study illustrating this discussion is the channel switching delay study which results have been reported in Section 3.2 and partially published in Fleury et al. (2011a,b).

Simulating test environments in a lab

Lab-based usability experiments usually involve the reconstitution within a laboratory of a typical environment in which the system under test is normally used. This technique has been called in sitro experiment, and aims at optimizing the tradeoff between control and ecological validity encountered when conducing evaluations in a traditional laboratory or in the real intended usage environment, respectively (Kjeldskov & Skov, 2007, Dahl, 2010). Simulating a typical use environment realistically contextualises the study and increases the realism experienced by participants during the test, which is expected to trigger more natural behaviour from them. On the one hand, some environments such as offices are straightforward to simulate as they require no to little specific equipment. These are therefore simple to recreate, and high ecological validity can be achieved easily. On the other hand some contexts are much harder to simulate either because they require specific equipment, or because the geographic and/or social surroundings are challenging. This is particularly true in mobile contexts, in which the user's attention is constantly split between navigating in the constantly evolving surroundings and the task at hand. Other hard to recreate factors include stress, risk assessment and handling, and realistic behaviour of transportation means. The following paragraphs review cases of such mobile and non-standard test environments.

Mobile settings

Almost by definition, mobile applications are supposed to be used on-the-move, implying a volatile surrounding within which the user is pursuing a certain goal (typically evolving toward a certain destination). Cognitive resources are thus carefully distributed between the navigation tasks (including physical movement and collision avoidance for instance in case of walking, and constant status re-evaluation in relation to the destination and other users of the space), and the tasks related to the mobile application. Reproducing such environment in a laboratory requires simulating the navigation-related tasks realistically. First and foremost, the difference between evaluating a mobile system while sitting versus while walking seems obvious and has in fact

been demonstrated empirically in a number of experiments. An example of such study is reported in Choi (2008), which investigated the effect of motion (still versus walking) and lightning conditions on user performance with mobile devices. Choi's findings show that the motion condition significantly affects reading time, text comprehension and associated cognitive loads. In this experiment participants were instructed to walk along a path marked on the floor of a laboratory. Furthermore the physical dimension of a walking scenario can be recreated using a treadmill, or having test subjects navigate through a path within the lab following a facilitator, as done in Kjeldskov & Stage (2004) and Barnard et al. (2005). Kjeldskov & Stage compared six various such test conditions: sitting, walking on a treadmill (at constant or varying speed), walking along a changing path in the lab (at constant or varying speed) and walking in a busy pedestrian street. Small yet no significant differences in number of critical and serious usability problems identified, performance, and workload could be attributed to the technique employed. Moreover, Barnard et al. suggest that treadmills are suitable for measuring performance times but inappropriate for difficult or stressful environments, as well as time- or safety-critical situations.

In addition to standard treadmills, omni-directional and spherical treadmills have become popular in recent literature for simulating walking scenarios within controlled settings. In these cases the walking simulator is usually coupled with virtual environments within which users can navigate freely. Recent projects such as CyberWalk[5] (Souman et al., 2008) and Virtusphere[6] (Medina et al., 2008) have explored innovative solutions for recreating such immersive 3D environments.

Focusing on the motion aspect inherent to simulated mobile contexts, Crease et al. (2007) emphasize the importance of test participants monitoring the environment and following a dynamic route when evaluating mobile application in simulated settings. The authors designed a test environment reproducing those constraints, based on colour-coded mats placed on the floor and projectors displaying information on the walls. In a typical use of this setup, test participants are asked to walk on the mats, avoiding hazard areas represented by one of the mat colours, which varies along the path (Lumsden & Drost, 2008). This effectively directs a large amount of users' cognitive resources toward their navigation tasks, simulating a demanding environment in terms of constant reassessment of one's position related to other elements present in the area.

Apart from focusing on reproducing motion, mobile related environments have been recreated by HCI researchers and practitioners via living labs. A typical example of such approach is recounted in Koskela et al. (2004), in which a young couple lived in a "smart home" for three months. During this period they used a mobile application to control various elements of the two-room apartment such as lights and curtains, and to monitor plants and electrical appliances. Another advanced living lab is the PlaceLab (Intille

[5]CyberWalk: http://cyberwalk-project.org/ (June 5th, 2012).
[6]Virtusphere: http://virtusphere.com/ (June 5th, 2012).

et al., 2005), which has been used not only to study ubicomp systems over extended periods of time (Intille et al., 2006), but also technology-motivated behavioural changes (Nawyn et al., 2006), sensor-based activity recognition (Logan et al., 2007), context-sensitive learning of foreign languages (Beaudin et al., 2007), and opportunistic reminders for medication intake (Kaushik et al., 2008). Living labs have been particularly employed to investigate health-related issues, and notably in Denmark a recent implementation of a similar testbed has been used to study how mobile applications can support diabetic patients and their families (Kanstrup et al., 2010). In such "instrumented home" (Intille et al., 2006), a number of sensors (including audio, video, pressure, and proximity) are placed around the rooms to collect data from which to infer information related to people's behaviour in relation to the technology being evaluated. An extreme example of such living lab is documented throughout MIT's Human Speechome Project (Roy et al., 2006), during the pilot phase of which 90,000 hours of video and 140,000 hours of audio material were recorded over three years and used to examine how a child acquires language (Roy, 2009). In all these experimental environments high ecological validity and environment control are achieved, especially when the sensors are discreetly located and the study period is prolonged in time. However as with the mobile sensors approach discussed in introduction to this chapter, the amount of data collected can render its analysis tedious if not hazardous: in the pilot experiment reported in (Intille et al., 2006), each participant generated 200-250 GB of data, acquired from about 350 sensors over 10 days; and the Human Speechome Project required to build special data storage infrastructures to host the 200 terabytes of audiovisual data captured over the course of the pilot study. Moreover, analysing such corpus required developing robust and semi-automatic techniques and tools. Additionally, privacy and ethical concerns need to be carefully addressed when digging into people's life in such details.

Non-standard environments

Generally speaking, working environments with fast pace and high level of stress, risk, and/or responsibility are some of the most challenging settings for conducting user research in. Hospitals are typical examples of such challenging environments. The pace of unfolding events, the large number and variety of the actors, and the complexity and specificity of the equipment are critical issues to tackle in situ and to simulate in a lab. Svanæs et al. identified the following three usability aspects impacting the evaluation of a mobile-EPR (electronic patient record) system. 1) Testing the system GUI requires display mirroring or device mounted video cameras to capture user interaction with the system. 2) Replicating physical and bodily aspects of the environment is critical to generate valid results. This can be achieved by placing real furniture in a space that mimics physical requirements (e.g. walking between rooms) and by recruiting real actors to perform for instance the role of patients. 3) Enough actors should be enrolled, and their interaction should be carefully recorded for later analysis (Svanæs et al., 2010, p. 31-32). The laboratory setup used for this study and described in Alsos & Dahl (2008) considers those issues and is argued to provide an optimal tradeoff between realism and control in terms of physical environment, scenarios and actors. The authors'

perspective on video recording is particularly interesting, as they recommend using multiple wall-mounted cameras over device-mounted ones to record interaction with the mobile system. This is in order to leave the recording as unobtrusive as possible.

Emergency response teams are another category of workers having very specific requirements related to the nature of their job, and for which exact environment simulations are virtually impossible. For instance in case of firefighters on the scene of a fire, the level of stress due to danger and real life test facilities are some of the challenging constraints to deal with in a test setup. In terms of design requirements, Jiang et al. determined that critical information about accountability, assessment, resource allocation, and communication need to be available to the incident commender in charge of the situation quickly and at all time. Furthermore, Jiang et al. (2004) argue that technological equipment in such situations should be as invisible as possible, as the effort should be focused on the people and environment. Under these constraints, evaluating new designs for supportive technology requires simulating the environment as realistically as possible and to involve trained professionals through a number of different evaluation phases (Klann et al., 2008).

Sometimes, the environment is challenging due to its physical constraints, which is the case for instance with vehicles such as cars, planes, not to mention large ships. The equipment required to conduct experiments in these environments and the risks due to potential system failure or human mistakes call for using simulators when testing technology in those settings. Despite the availability of inexpensive, realistic and publicly available simulators, user experience researchers dealing with such environments often rely on professional training simulators instead of their cheaper counterparts. For instance with cars, complementing the review conducted in Kjeldskov & Stage (2004), some recent studies implemented professional solutions such as STISIM Drive[7] (see for instance Hu et al. (2007)), while others relied instead on (serious) games such as Racer[8] (Sodnik et al., 2008). Similarly with planes, the commercial simulators X-Plane[9] and Microsoft Flight Simulator[10] received official certification to train pilots (Williams, 2011), yet they generate mixed results when considered as a platform for instance to train army helicopter pilots (Proctor et al., 2004, 2007). Finally, borrowing equipment from training academies to conduct realistic simulations offer great potential in terms of fidelity and cost. This approach was for example demonstrated successful at reproducing the bridge and control room of a large transport vessel while remaining controlled and safe for test participants (Kjeldskov & Skov, 2003). It is important to mention that the test subjects in this experiment (as in those involving army helicopter pilots and firefighters) were trained professionals with years of practice.

[7] STISIM Drive: http://www.stisimdrive.com/ (June 1st, 2012).
[8] Racer: http://www.racer.nl/ (June 1st, 2012).
[9] X-Plane: http://www.x-plane.com/ (June 1st, 2012).
[10] MS Flight Simulator: http://www.microsoft.com/games/flightsimulatorx/ (June 1st, 2012).

Other hard to simulate contexts include natural disasters, riots, battlefields, subaquatic and extra-atmospheric settings, among others. However challenging and thus interesting these setups might be, they are hardly relevant for this work and will therefore not be discussed here[11]. Nevertheless, this short introduction to non-standard environments confirms that the findings from Kjeldskov & Graham (2003) concerning laboratory experiments for mobile systems also apply in such settings: even though high fidelity is a strong requirement when testing holistic user experience, cheap simulations seem appropriate to investigate specific user interaction aspects when the use situation does not require trained professionals to take part in the study. Stepping out of the highly stressful environments described previously, and focusing on smaller scale experiments than those typically conducted in living labs, the following integrates the lessons learned from mobile and non-standard test environments to describe a flexible and affordable test facility that helps immerse users in mobile settings thanks to audiovisual stimuli.

A setup to conduct in-sitro evaluations

Figure 6.8 illustrates the usability tent further described in this section. The top diagram depicts two possible configurations of the tent, adapted to mobile and desktop systems. The back end communicates with the test system by way of cable or wireless connection, and plays the audiovisual stimuli recreating the atmosphere of the environment simulated. It is also in charge of recording audio and video material of the user interacting with the system under test. Participants sit or stand in a dark test section of the tent, facing the video projection of a scenario relevant for the evaluation while the related auditory stimulus is played in the background.

As the diagram in the figure shows, the technical requirements for setting up this environment are minimal. Apart from the tent, a computer hooked up to a video projector and a set of speakers are required to generate the audiovisual stimuli, while a microphone and a web-camera capable of dealing with low light conditions can handle the capture of participant reaction. Additional equipment can easily be added to this basic set, depending on the experimental conditions. For instance in the present case, the test participants were not required to think aloud and thus the audio recording, irrelevant for the data analysis, was recorded for documentation purpose only. However in case participant spoken reactions are critical to the evaluation, carefully positioning a number of microphones within the test environment would be required in order to deal with the audio background, which would need to be subtracted from the recorded audio feed(s).

Although not disseminated through peer-reviewed venues, the usability tent described previously has been used in many student projects conducted

[11] The reader interested in state-of-the-art virtual environment simulators for battlefields based on gaming technology could look into the "ultimate Battlefield 3 simulator", built for British TV show *The Gadget Show* and featuring an omni-directional treadmill, motion tracking technology, a 360 degree domed screen, a gun-shaped controller, and paintball guns that shoot at the player when their in-game avatar gets shot, the demonstration of which is available on YouTube: http://www.youtube.com/watch?v=eg8Bh5iI2WY (June 5th, 2012).

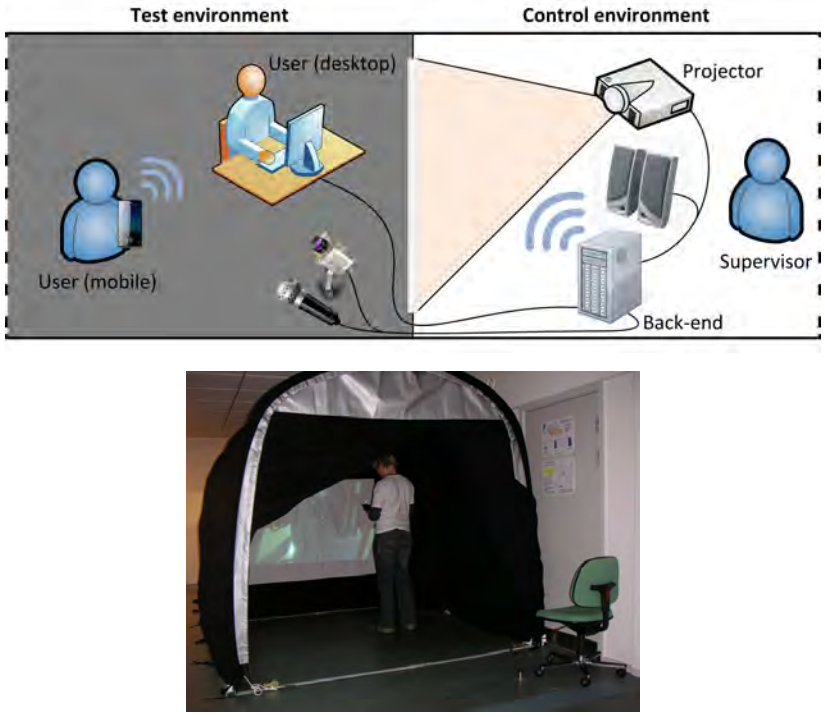
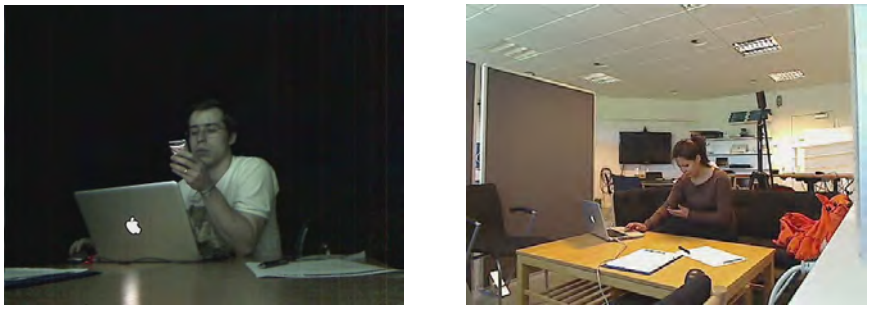


Figure 6.8: The usability tent immerses test participants via audiovisual stimuli.

at Aalborg University, in the purpose of studying as diverse topics as minimizing sound-induced discomfort when sitting in the dentist chair (Jørgensen et al., 2008), to guiding procedures for wayfinding in car parks (Grønne et al., 2009), or to evaluate influence of MicroShade patters on user preference for a view through a window (Mortensen et al., 2011).

Measuring the impact of test environment on acceptability of channel switching delays on a mobile device

In this case study we were interested (among other parameters impacting results discussed in Section 3.2), in comparing a quiet room to the usability tent described in the previous paragraphs as test setups to evaluate a specific aspect of user experience with mobile television. On the one hand the quiet room offered no extra visual or auditory disturbances during the test session, allowing the participants to focus solely on the test. On the other hand, the usability tent simulated a changing exterior environment. A view of test subject in both test environments is provided in Figure 6.9. The audiovisual scenario to be played in the tent is a 12 minutes bus ride filmed from a first person viewpoint. The video plays in loop in case the evaluation takes longer than 12 minutes (which rarely occurred), and is accompanied by the corresponding soundtrack, played at a level similar to experienced in a real bus.



(a) Inside the usability tent. (b) In the quiet room.

Figure 6.9: Screenshots of video recordings in the two environments used to test acceptable channel switching delays.

The hypothesis concerning the effect of the test environment on perceived acceptability of channel switching delays was formulated as follows: *The ratings of transition delays vary significantly depending on the test environment in which the video clips are played*. To investigate this hypothesis, we performed an analysis of variance (ANOVA) of the distribution of ratings among clips that have been experienced with the same delay duration in both the quiet lab and the tent. No significant difference was found. The fact that the test environment does not significantly affect the ratings of transition delays is unexpected, yet this indicates that researchers can study delay transitions in a standard usability lab instead of simulating realistic test conditions. When digging into the video recordings of users during the experiment in the tent setup, it becomes clear that all participants focused essentially on the evaluation task, and glanced at the video projection only a few times during the session. Similarly as during a bus trip when one needs to pay no attention to the surroundings, the participants directed their cognitive resources to the primary task, and the audiovisual stimuli served as background only.

Two logical next step to this study are to 1) repeat the channel switching delay experiment in a scenario that requires paying attention to the surroundings, for instance by monitoring a stop at which to exit the bus, rather than using the setup for merely providing background to the test, and 2) conduct a similar experiment during an actual bus trip. This leads us to express three new hypotheses that remain to be verified. First, considering an earlier experiment showing that worst content quality was judged acceptable by participants evaluating mobile TV content in context compared to in a lab (Jumisko-Pyykkö & Hannuksela, 2008), we expect that if real context indeed matters in such studies, longer channel switching delays would be deemed acceptable in situ than in vitro, as in the study presented above. Second, we expect that during the "passive" time of the commute, the cognitive resources allocated to monitoring the trip status would not significantly deviate from those presented in this section and would thus yield similar results. Third, user tolerance of delays during critical times (e.g. shortly before the bus arrives and the final stop or potential connections–scenarios not evaluated in

the present study) are expected to be significantly lower, due to the increased stress provoked by the environment monitoring task.

As a take away from this experiment, one need to consider carefully the importance of the realism aimed for when setting up a simulated environment. As illustrated by the aforementioned case study, reproducing a background environment is not necessary to study specific user experience issues with mobile technology. The literature and previous experiences with the test setup presented in this section tells us however that such usability tent is beneficial to other types of users studies, including Wizard-of-Oz experiments. This technique is discussed in the next section, although separately from the usability tent.

6.4 Wizard-of-Oz usability experiment

In this section, the classic Wizard-of-Oz (WOz) technique used to conduct the usability experiment of four content transfer methods described in Section 3.4 is discussed. In the following, previous work related to the evaluation of technological systems via a WOz approach is briefly reviewed, bringing forward critical issues to be dealt with when applying such experimental method. These issues are then discussed in the light of the content transfer experiment, the results of which have been discussed in Section 3.4 and partially published in Fleury et al. (2011a, 2012b).

The man behind the curtain

Evaluating complex interactive systems can be costly if one needs to implement fully functional prototypes to test design concepts or interaction schemes. Simulating software response by a human operator hidden from test subjects is therefore an appealing approach to test such systems at a low cost and in a timely fashion. Wizard-of-Oz studies, originally also referred to as PNAMBIC, or "Pay No Attention to the Man BehInd the Curtain", are a popular approach implementing this concept: A human operator (the wizard) operates an interactive system used by a test subject, who is unaware that the system responses are due to the wizard. The test participant is thus led to believe that the system tested is fully functional. The technique became popular in the early days of speech recognition-based natural language interfaces (Green & Wei-Haas, 1985, Fraser & Gilbert, 1991, Dahlbäck et al., 1993) and multimodal systems (Salber & Coutaz, 1993). Unspecific to such interactive systems, Fraser & Gilbert argues that successful WOz studies require 1) the simulation to be possible, which needs to consider human limitations, 2) the system must be specifiable, for the wizard to simulate its behaviour accurately, and 3) the simulation must be convincing enough so test subjects believe the interaction takes place between them and a computer (Fraser & Gilbert, 1991, pp. 82-83). In case multiple wizards are required, Salber & Coutaz suggests considering using either specialized wizards dedicated to each task, or interchangeable wizards switching between tasks. The latter option is believed to help spread the overall cognitive load required from the wizards among them. Additionally, a *superwizard* might be useful in supervising the wizard team (Salber & Coutaz, 1993, p. 223).

The basic setup of WOz studies has been illustrated in Gould et al. (1983) and is reproduced in Figure 6.10. The wizard and test participants sit in different rooms, and the interfaces each of them use are linked within a closed system in order for the wizard to keep track of what the participant sees and react accordingly.

Considering the ease with which prototype developers could implement and test their design ideas via WOz studies, some attempted to develop generic interfaces for wizards. An early example of this has been developed by Wesselman & Green for command language, menu-oriented and natural language interfaces. The software package was designed for dual screen setups–one for the test subject, and one for the wizard and adopted the

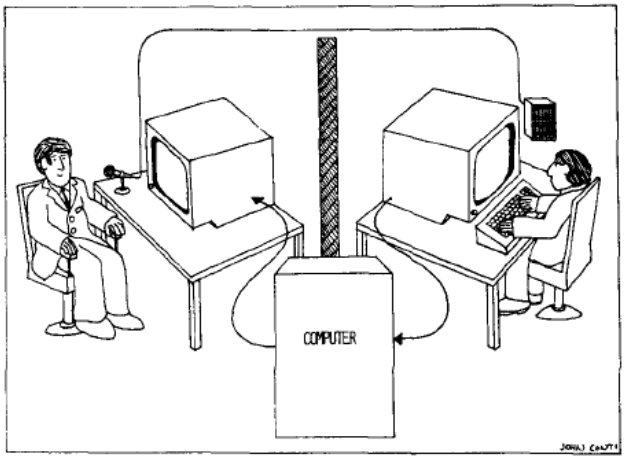


Figure 6.10: *Schematic of the Experimental Setup* (Reproduced from Gould et al. (1983), p. 296).

WhaYKIWhTSS "What You Key Is What The Subject Sees" principle. The wizard watches on the screen the user commands as they are typed in, and uses a keyboard enhancer to simulate the system responses to the user input. The dialogue between the wizard and test subject is logged for later analysis.

More recently, WOz studies have been applied to a wider range of applications, including enterprise-wise groupware (White & Lutters, 2003) and, closer to the concern of this thesis, ubicomp systems as reviewed in Carter et al. (2008). Examples of applications include home care (Consolvo et al., 2004), mobile speech-to-text transcription (Matthews et al., 2006), and augmented reality (Dow et al., 2005a). From a methodology perspective, Schlögl et al. (2010) reveals and discusses issues faced by wizards while observing test subjects. Four scenarios involving speech recognition systems were used as the evaluation framework, and a prototype interface supporting the wizard's tasks was designed and tested by a few experienced wizards. Based on the feedback collected from the wizards who participated in the usability evaluation of the systems, Schlögl et al. identified a number of usability issues and design guidelines for a generic WOz interface. The main characteristics of such interface are in accordance with the earlier recommendations expressed in Salber & Coutaz (1993) and include 1) a limited amount of information available to the wizard to reduce the cognitive load required to handle the tasks, 2) constant visibility of the test script to help keeping track of the interaction, 3) balance in the information available to the wizard about the participant status, to help mimicking a real system (for instance a wizard should prompt non-responsive participants neither too early nor too late), and 4) correct amount of control over the experiment flow allocated to wizards.

In an iterative user-centred design process, Dow et al. argue that WOz can be used not only early in the process to "simulate underdeveloped technology", but also near the end either to supervise the fully implemented system

or to simulate specific aspects of it, as well as along the design process to stimulate transition toward the final design (Dow et al., 2005c). The authors also point out that even though it is not frequent in the literature, wizards sometimes assume other roles than that of the controller of a realistic system. For instance they can act as test supervisors and guide participants through the experiment, or provide responses exceeding current computing possibilities. As with all evaluation strategies, WOz has been argued to be best used in combination with other investigation methods, and especially *experience prototyping* (Reilly et al., 2005).

Another interesting perspective on WOz setups is put forward by the observation in Reeves & Nass (1996) that "people treat computers, televisions and new media like real people and places". Assuming this *media equation* holds, the user experience with interactive systems should be similar to human-human interaction, according to various dimensions explored in *The Media Equation*. The experience should thus be even more similar if the interactive system is actually human-operated. For instance in the experiment reported in Mäkelä et al. (2001) simulating interaction with a robot-doorman, test participants displayed human-machine behaviour similar to human-human interaction. This tendency puts more emphasis on the need for the wizard to study thoroughly how the system under test is expected to behave once fully implemented, and base the mediated interaction with test participants accordingly.

Wizards on the loose

If WOz studies are mostly used in controlled, laboratory environments, some have ported the technique to field studies as well. For instance, in order to investigate the feasibility of automatic interruptibility detection, Hudson et al. deployed a system capturing the level of interruptibility of workers throughout the day, based on a number of simulated sensors. In a more complex context, wizards in Dow et al. (2005b) were discreetly following test participants during an audio tour throughout a cemetery. As the participants progressed through the tour, they would request audio commentary related to their immediate location. The wizards received the requests and loaded the appropriate commentary. More recently, work by de Sá et al. has confirmed the appropriateness of WOz for evaluating applications for mobile devices at an early stage of their design through in situ or participatory experiments. The research team devised an evaluation framework (de Sá et al., 2008, de Sá & Carriço, 2009) and guidelines (de Sá & Carriço, 2008b) including not only the test setup phase but also data collection and analysis.

To support such evaluations "in the wild", various tools have been developed. An example of which is Momento, a tool that uses SMS and MMS as a communication channel between the test participant and the system, simulated by a researcher controlling the experiment from a remote desktop computer (Carter et al., 2007). The advantage of such approach is the scalability of the experiment, as nothing needs to be installed on the participant devices and no training is necessary. Additionally, web technologies seem another good approach to such systems, as discussed in the case of WOEB (Bellucci et al.,

2009). WOEB is a framework and environment for setting up WOz experiments of mobile interactive system. This approach offers more functions and let researchers evaluate more specific systems, at the expense of test scalability. Finally, WOz are particularly relevant to the design process of location-based applications, which are resource demanding in terms of development and testing. Tackling this issue, Topiary is a framework that focuses on location based mobile systems, with which application designers manipulate active maps modelling the location of users, places and things (Li et al., 2004, 2007b). Topiary has been successfully used in coordination with storyboarding activities.

Magical video transfers

In the study described in Section 3.4, participants evaluated four interactive techniques for transferring content from a mobile phone to a television set. The experiment took place in a usability lab reproducing a living room environment, with sofas and a large TV screen attached to the wall. As depicted in Figure 6.11, two web cameras installed in the test room allowed the wizard to control on which of the mobile device or the TV screen the video content should be displayed, in reaction to the test participant's actions.

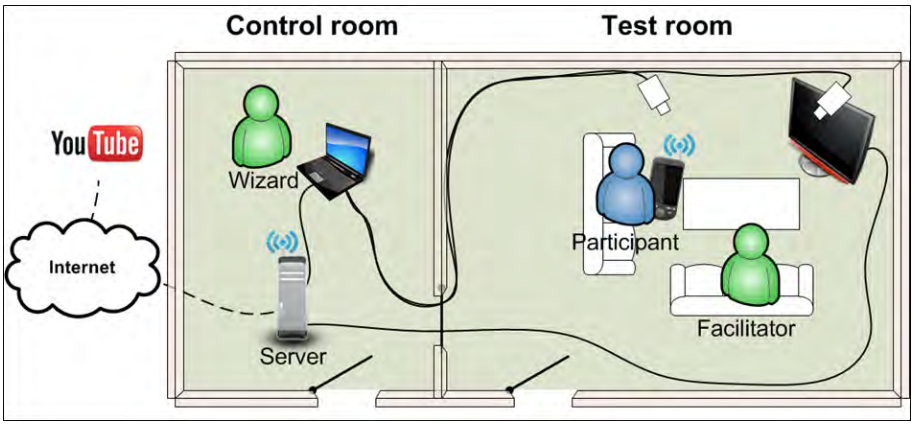


Figure 6.11: Physical configuration of the Wizard-of-Oz content transfer experiment.

This approach was very successful at simulating near perfect system reaction, and some participants commented on how well the transfers were performed and inquired on the underlying technology. It should be noted that a certain amount of system response delays was introduced in the setup due to network latency. This arguably added to the realism of the system, which responded fast but not suspiciously so. Except from Browsing, the Tossing, Pointing and Proximity interaction schemes were controlled by the wizard via a web interface which directed the video to be paused on one device and simultaneously resumed on the other. In the following, initiating the transfer refers to this action of pausing the video playback on the mobile phone and resuming it on the TV screen.

Tossing The wizard instructs the system to initiate the content transfer when the test subject performs the tossing gesture towards the TV set, while holding the mobile phone in the hand.

Pointing When the participant points the mobile device towards the TV screen, the wizard instructs the system to display an icon representing the TV under the video feed on the mobile phone. The content transfer is then initiated by the participant clicking on the icon.

Proximity Here the wizard instructs the system to initiate the transfer when the test participant holds the mobile phone within few centimetres of the TV screen.

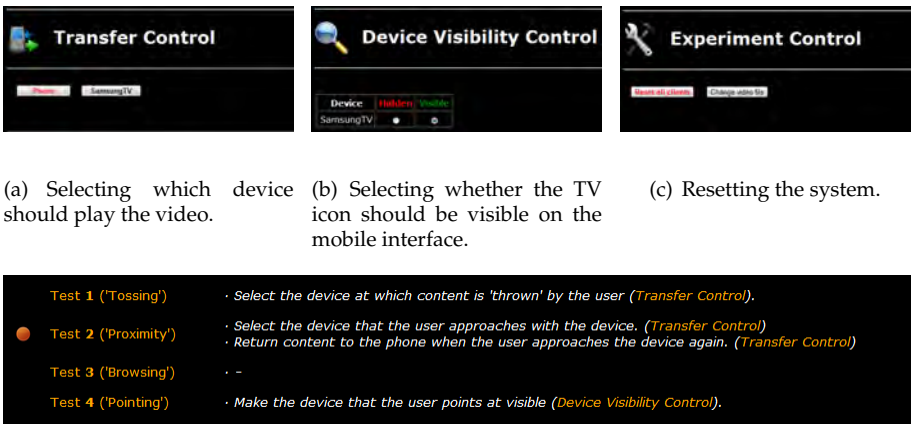
Interface

As also argued in Bradley et al. (2009), web based interface are very suitable for WOz experiments. To comply with the requirements introduced previously, the interface manipulated by the wizard should be kept as simple as possible and support the wizard in keeping track of the experiment process. The control panel developed for the wizard of the content transfer experiment consisted in three elements: the video feeds from the two web cameras, the audio track from one of the cameras, and a non-scrollable web page supporting the few tasks to be performed. As explained above, the wizard was in charge of two tasks during the experiment: to select on which device the video should be played (Tossing and Proximity), and to select whether an icon representing the TV set should be displayed on the mobile interface (Pointing). These tasks are supported by the interactive elements illustrated in Figure 6.12 (top row). The tools to reset the experiment from the control room are also depicted in the figure (c). The bottom image in the figure illustrates the menu reminding the wizard which method is being currently evaluated, and the associated task to be performed. This menu is updated automatically when the test participant selects one of the transfer methods on the mobile device menu.

Additionally, between two participant sessions, the wizard was in charge of modifying the order in which the four transfer methods are presented to the participant on the mobile device, to reflect the order they should be experienced. This was done via a separate dedicated web page, in order not to clutter the main control panel by information irrelevant during the experiment.

Synchronization

One of the (if not *the*) main issue in WOz experiments is to synchronize system response time with participant action, to match the participant expectation toward the system tested (Salber & Coutaz, 1993). Using two video feeds from cameras placed at different locations in the test room (depicted in Figure 6.13), and the audio feed from one of them, the wizard in the content transfer experiment could precisely follow the ongoing test and react in a timely fashion (the latency experienced due to the cameras and video rendering system was less than 250 ms).



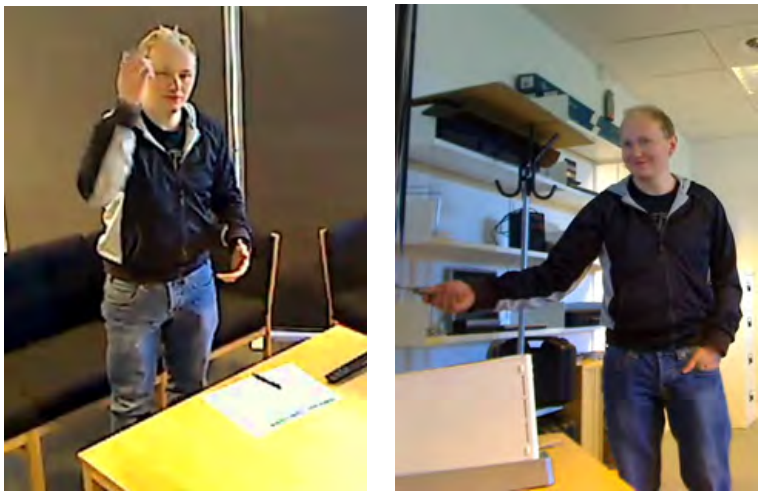
(a) Selecting which device should play the video.

(b) Selecting whether the TV icon should be visible on the mobile interface.

(c) Resetting the system.

(d) Menu indicating the method currently evaluated.

Figure 6.12: The elements of the wizard's control panel.



(a) Control camera 1.

(b) Control camera 2.

Figure 6.13: The two control cameras for the wizard to keep track of the experiment remotely. Images reproduced with permission.

Ensuring timely system reaction was especially critical for the Tossing and Pointing scenarios, which relied on gestures involving the user's arm. Participants reacted differently to the short delay between performing the gesture and the video playback to be resumed on the TV set. In the Tossing case, some tried the gesture again (as if it could have been misunderstood by the system supposedly recognizing it), and in the Pointing case, some aimed the mobile device at other areas of the TV screen (as when an infrared remote control is misaligned with the TV's receiver sensor). Some other participants

simply waited, keeping their arm hanging in the air for the transfer to be completed.

Team work

The success of the WOz approach relies on the interaction being successfully simulated. The facilitator instructing the participant has no alternative but to trust the wizard in performing his role correctly and at the right moment. Strategies need to be arranged during the design process of the experiment, in order to prepare backup solutions in case technical issues occur. Indeed, communication between facilitator and wizard should be avoided, as it would create an awkward situation in front of the participant, who might become suspicious of the wizard's role and question the test setup. To design such fallback strategies, the research team should first commonly agree on the set of rules to be strictly followed by the wizard during the evaluation, as suggested in Mäkelä et al. (2001). Additionally, they should identify potential weaknesses in the system and then agree on workaround procedures to adopt during the actual test with participants. For instance in the content transfer case study, the prototypes relied on timestamps to be read and written asynchronously on a web server, thus setting the point in time at which the video should be resumed on the other device once it was paused on one. This easy to implement solution is however fragile as network instability can prevent the timestamps to be written or read at the correct time.

During the experiment, the fallback strategy agreed upon in case such misbehaviour would happen (clearly identifiable as the video playback would pause on the mobile device but not resume on the TV) was to relaunch the mobile application once, and in case of a second misbehaviour the wizard would initiate a complete reset of the system, deleting any potentially faulty timestamp. Such strategy may seem obvious or simplistic, but it is crucial to devise one and follow it in order to deal with critical situation in the absence of communication between facilitator and wizard. Additionally, since unpredicted events may occur in the course of the experiment, the wizard should be ready to adapt to any unplanned sets of actions.

The wizard's takeaway

Based on the experience gained from the content transfer experiment, the following conclusions could be drawn, confirming earlier findings and opening for further directions in WOz research.

WOz studies are well suited for usability evaluations of complex interactive systems. Time efficiency in terms of prototype development is one of the main benefits of this approach to usability testing. In particular when evaluating variations of a conceptual interaction model (such as transferring video content from one device to another, as discussed here), both the user interface and the wizard interface to be implemented are easy to replicate and the development phase is minimized. More focus can be thus placed on other aspects of the experiment, such as the evaluation procedure or the setting.

Co-development of the experiment between facilitator(s) and wizard(s) is crucial. Both parties need to share a common understanding of the test system and of the evaluation procedure in order to ensure a coherent and convincing performance in front of test participants.

Scripts are essentials. As part of the experiment's co-development process, detailed scripts of the procedure for both the facilitator(s) and the wizard(s) should be developed, including backup plans in case potential system failure occur. This helps maintaining a high level of realism throughout the evaluation, even though problems might occur. In such case, following the agreed upon procedure also helps the facilitator handling the situation.

Final draft

CHAPTER 7

SUMMARY OF PART II

This chapter summarizes what we have learnt by applying the user research methods described in Part II of this dissertation. In the following sections, conceptual and prototype based methods are discussed separately, as introducing another classification seems irrelevant at this point. Common to both categories however are the four types of findings extracted: benefits, drawbacks, requirements and observations.

7.1 Conceptual methods

Applying the four exploration strategies discussed previously (online cross-cultural survey, scenarios, drama-workshops, and drawings), led not only to the verification of previous claims in the literature, but also to the observations of new paths calling for discussion and future research.

Benefits

The survey, drama-workshop, and drawings all proved to generate useful and complementary data at a limited cost. In addition to their cost-efficiency, those three methods are particularly interesting when used in complement to each other as they describe well the qualitative/quantitative axis and thus offer very different perspectives on the topics evaluated. For instance in the context of this thesis, all three methods were used to explore people's everyday use and personal connection with televisions and mobile phones. On the one hand, the survey provided generalizable and statistically processed data, comparable across two populations of interest. On the other hand, the drama-workshop provided in-depth ethnographic information about one of these two cultures. In-between these two approaches, the drawings revealed personal matters and thus hardly generalizable as such, yet through a semi-controlled activity allowing cross-cultural comparison. Considered in-

dividually, each method demonstrated the positive characteristics described in the following paragraphs.

First of all, setting up online surveys is nowadays fast and easy, given that the researcher has basic knowledge of web technologies. This is especially valid if the sequence of questions to be asked is linear, in which case the survey can be set up using largely customizable and free tools. Similar tools also support more complex questionnaires, for instance including conditional branching, although they may require more technical knowledge in order to be customized. Additionally, conducting an online survey in two countries where language is an issue requires engaging translators in the research project. In our case, one translator per target language was found sufficient to deal with the limited complexity of the survey in terms of number of questions and topics covered. More than simply translating the questions and answers, the translators also provided culturally relevant advice on how to formulate the questions and to interpret the results. In terms of recruitment for such study, direct personalized emails to ambassadors are found to greatly help enlarging the sample population.

Regarding the drama-workshop method, a few general advantages put forward in the literature could be validated though our own study. Relatively easy to set up, theatre-inspired techniques are valuable for developing ideas, for understanding context of use, and for exploring emotional and social dimensions of user experience with technology. They also put forward UX elements that would otherwise go unnoticed. Additionally, decontextualizing the use of a technology product helps understanding its limits, as demonstrated through the mini-story created by participants from randomly combined everyday life elements.

Finally the use of participant-generated drawings appeared as an invaluable approach to investigate user experience related to technology. The method facilitates the collection of personal data in a timely fashion, and can be applied to a large sample at a relatively low cost. Moreover, it is argued that the paper sheet provides a reflective personal space within which participants can not only express personal matters freely but also reflect on their own behaviour. As part of a workshop as it as been used in Japan, such an activity helps creating a relaxed atmosphere supporting creativity.

Drawbacks

The methods discussed previously also present a number of shortcomings that researchers should be aware of. Online surveys for instance suffer from various biases, including sampling, coverage, nonresponse, measurement, and design and implementation ones. The latter issue is maybe the least discussed in the literature, although it is quite clear that usability issues related to how the survey is accessed (specifically related to cross-browser compatibility) may alter the survey's look-and-feel and perhaps more importantly how it functions. When conducting cross-cultural surveys, one needs to be ready to tackle language issues impacting the results and potentially prevent-

ing comparison. Finally, using online social networks such as Facebook and Twitter for recruiting online survey participants can be more challenging than it seems depending on the study criteria.

The limitations of drama-workshops experienced in the study reported in this thesis confirm previous claims from the literature. Researchers engaging in such activity should keep in mind that role-play workshops only provide the perspective of the user, which should be confronted to that of the designer. Moreover, the reality enacted tends to be idealized, taking shortcuts and omitting potentially crucial details. Furthermore, if drama-based methods help emphasizing some aspects of user experience, they lack the ability to question them. Further investigation should thus be carried to provide a more thorough analysis of the results obtained with such techniques.

Similarly, drawings alone lead to interpretation issues, and require further analysis, ideally in the form of follow-up interviews with the authors. Moreover, drawings are influenced not only by direct environmental factors such as the experimental setup, but also by significant on-going events. On a more practical note, it was found that when asking people to create drawings on a sheet of paper, the space allocated to drawing on the page should be small enough not to intimidate participants with what could be associated with a white page syndrome.

Finally, the use of scenarios to be built upon throughout the course of a research project and derive relevant user experiments also presents limitations. Scenarios are indeed impacted by various forces inherent to multi-partner research projects such as CAMMP. Firstly, each partner's own internal dynamics modify its interest in the project and its expected outcome, which may give the project new directions. Secondly, a technology oriented project needs to constantly integrate the rapid changes in the technology. As a result of these contradicting forces, the project's overarching goals may remain constant yet necessitate readjusting the scenarios involved in achieving them. In a cyclic project such as CAMMP, a scenario deemed critical at the onset of the project may very well become irrelevant after the first iteration, whereas unplanned scenarios may emerge and grab the various teams' attention. A research strategy needs to be flexible and take potential such changes into consideration. However as a consequence, following up on studies may sometimes be hard when the general interest focuses away from a topic after it has been explored once.

Requirements

A number of requirements can be formulated regarding the conceptual methods discussed based on the experience learned by applying them to the study of user experience with media technology. These can be summarized as follows.

Cross-cultural online surveys

- Knowledge of web technology is required to conducted Internet-based research.

- Basic knowledge of web technologies allows generating fully customizable online questionnaires.
- Translators should be considered part of the research team.
- Careful wording of the questions is critical in cross-national surveys, and will most likely influence the answers.
- The initial seed of ambassadors used when recruiting survey respondents should be largely connected and influential.
- Statistical analysis methods need to be carefully selected when analysing survey results.

Drama-workshops

- Facilitators of role-play workshops should support the idea generation process.
- Facilitators of role-play workshops should help participants creating their play.
- Analysing results from drama-based workshops requires focusing on the core issues investigated, which can necessitate to be detached from secondary information in the plays.
- Analysing results from drama-based workshops also requires letting topics naturally emerge from participants' plays.

Drawings

- Drawings should be used in triangulation with other research methods.
- Analysing results from drawings requires focusing on the core issues investigated, which can necessitate to be detached from secondary information embedded in the drawings.
- Analysing results from drawings also requires letting topics naturally emerge from participants' drawings.

Observations

Complementing the findings summarized above, a few observations made during the drama workshops and drawing-base experiments are worth mentioning. For instance it was noticed that both methods reflect cultural characteristics, such as the Japanese working hard toward consensus during group work, and the differences between the Japanese and the Danes when depicting emotions. Specific to drawings, it is interesting to note that this type of activity leads to self-reflection and expression. With regard to theatre-based methods, the *future technology workshops* as well as the *drama workshops* approaches are good inspirations for setting up such study, while Svanaes and Seland's evaluation framework helps monitoring the workshops and analysing its results.

7.2 Prototype based methods

Similarly to the conceptual methods discussed previously, performing situated task-based semi-structured interviews, lab-based simulated usability experiments, Wizard-of-Oz usability experiments, and remote SMS prompting led to the formulation of a number of benefits, drawbacks and requirements summarized in the following paragraphs.

Benefits

Our experiment with the mobile TV prototype conducted in the university canteen combined contextual inquiry, task-based subjective assessment, and semi-structure interviewing. This combination of techniques proved to be powerful, cost-efficient, and ecologically valid when evaluating user experience with existing media technology products. Situating the interview provided ecological validity, the canteen area being a suitable environment to evaluate mobile television in a social context. Moreover, asking participants to complete tasks with the prototype enabled systematic data collection and comparison. Additionally, the semi-structured nature of the interview allowed covering a wide range of relevant topics in a timely fashion. The data collected from the predetermined questions can be compared between participants, and the topics naturally emerging during the discussion provides insightful, subjective, and quotable opinions.

Similarly the usability tent used for the channel switching delay study provides, as such, a cost-effective solution to recreate an exterior context yet allowing precise control of the experimental factors. Despite its shortcomings discussed in the next section, such a lab equipment is seen as highly valuable and its use should be studied more thoroughly.

Furthermore the Wizard-of-Oz approach adopted in the content transfer experiment confirms prior literature regarding the advantage of the method. It is indeed well-suited for studying complex interactive systems at an early stage of the design process, by simulated the intended behaviour of a future product. It is a cost-efficient approach to comparing different concepts while minimizing implementation effort. Together with the usability tent, WOz studies are well suited for discount, guerilla usability testing.

Drawbacks

The main drawbacks encountered while applying the aforementioned techniques concern the remote SMS survey. The method is indeed highly sensible to the following factors, which in our case have lowered participation and response rates, and led to the termination of the study prior its expected date. Long delays between recruitment and survey start, communication intermediaries between participants and the research team, software issues, and low incentives are expected to have participated to the limited conclusions we could draw from the survey.

The remarks formulated in the case of conceptual methods concerning the use of scenarios throughout a research project also apply to the prototype based methods presently discussed.

Requirements

The challenges faced during the remote SMS survey can be turned into requirements for future such research, formulated as follows.

- Direct communication with participants is critical to ensure the purpose and procedure of the study is understood correctly by all participants.
- Similarly, clear and repeated statements about the nature of remote SMS surveys is required to ensure their success.
- The initial sample population should be large as dropout rate can be high during remote SMS surveys.

The WOz study also led to the formulation of requirements in order for such study to be successful.

- Woz studies should rely on a detailed script of the planned user interaction with the tested system.
- The simulated system response time must match the user expectations.
- Both the wizard and the test facilitator should be involved in the design process of the prototype used in a Woz study.
- Strategies to deal with potential issues with the prototype should be agreed upon by the wizard and the test facilitator.
- Wizards need audiovisual feedback of the ongoing experiment at all time.
- The control interface manipulated by the wizard should be simple, uncluttered, and present the status of the evaluation at all time.
- The wizard should anticipate unplanned user actions to ensure consistency in the simulation.
- Allowing the wizard to reset the software may alleviate issues with the prototype.

Observations

Finally, the following observations related to in-lab simulated environments and remote SMS prompting are found noteworthy. As noticed while evaluating channel switching delays on a mobile device, providing contextual background to an activity that requires neither physical mobility nor particular attention to the environment does not affect results. Concerning SMS-based experience sampling, we found that the response rate, and the reply delay distributions of the most active participants are good estimates of the overall test population.

Part III

Discussion and conclusions

Final draft

"It's inevitable that the whirl-pool of electronic information movement will toss us all about like corks on a stormy sea, but if we keep our cool during the descent into the maelstrom, studying the process as it happens... we can get through."

Marshall McLuhan

A scientific work would be incomplete if it lacked self-criticism and failed to suggest paths for future elaboration based on its findings. In this final part, we provide clues for verifying the validity of the results exposed in previous chapters, conclude on our research questions, discuss the limits of the research project, and open for potential follow-up research topics.

More precisely, Chapter 8 reviews the trends discovered in Part I in the light of previous such work, reflects on the research methodology adopted, and proposes a framework for evaluating the performance of applying various user research methods relative to the cost of implementing them.

Then, based on the findings summarized in chapters 4 and 7, and the previous discussions, Chapter 9 answers the research questions and associated sub-questions formulated in Introduction. By answering these questions, the chapter thus concludes the present dissertation. In addition, Section 9.2 reckons some limitations to the work reported in this thesis, and suggests directions for potential future work.

Final draft

CHAPTER 8

DISCUSSION

8.1 Near future trends on media convergence

On a global scale, economies are converging, which is to say that the growth rate of smaller economies is higher than that of the larger ones. Technology is responsible for the increasing rate at which this happens. The big players of the media economy such as Google and Facebook achieved internationally recognition, similar to Coca-Cola or Nike a few decades ago. For end users, those brands become technology ambassadors and remodel our relationship with media. People "google" things (including themselves), and exchange links to Facebook profiles when meeting for the fist time. The most popular online social networks aggregate communities and offer tools for them to develop and for their members to communicate.

It is thus crucial to study these emerging practices as they reshape the way people relate to and access media. From the outcome of the studies reported throughout this dissertation, we have identified not only general trends concerning future media technology, content, and human-computer interaction, but also specific usability aspects of upcoming services such as mobile TV and second screen features.

Overall, the trends identified in Miller (2012) concerning the near future mobile TV landscape have been generally confirmed throughout the studies presented in this dissertation. Miller defines mobile TV as "*episodic and long-form content, typically of half-hour or one hour duration, similar in style to that which is broadcast on traditional networks*" (Miller, 2012, p. 1). However, we believe that these trends in fact reflect a more general shift in media consumption paradigms than the mobile TV market alone. Following the report's nomenclature, one can expect the five following directions to drive the future of the converging media market.

Changing consumer attitudes Compared to a few years ago, people have included new media-related habits to their everyday life. By studying the media consumption patterns of today's early technology adopters, this thesis provides an informed insight of the soon to become standard media life in ICT societies. Nowadays' one expects more flexibility in where, when, and how to access one's digital content. Furthermore, audiences expect more interactivity with content providers, and a growing mass of end-users turn into produsers, taking part in the national (and global) debate by contributing with user-generated content.

Ubiquitous WiFi Internet is becoming a commodity, and "free" access to the web is now the norm at home, at the office, in most hotels and in an increasing number of public places. Connectivity on-the-go (in non-static environments) is however still an issue according to the participants in our studies, for whom network availability, quality of service, and price are major concerns. The rapid development of mobile broadband technology is however expected to alleviate these issues and rapidly fully support mobile lifestyles.

Entrance of tablets to the market Tablets are expected to play a major role in front of televisions, and broadcasters see the platform as a game changer in how audiences interact with TV content. In fact, interactive services are being tested and receive franc success by technology-minded audiences.

Internet TV and IPTV Soon the switchover from analogue to digital television will be completed on a global scale. All-digital TV content means easier distribution over a larger number of channels: TVs, PCs, and mobile terminals are now equally capable of delivering TV content to end users. Relying on IP technology to transmit content also means that a return channel becomes available, supporting the interactivity called for by audiences and content providers. Both parties indeed have a growing interest in developing a bi-directional communication channel.

The trend for multiscreen The concept of multiscreen can be understood in two related ways. Firstly, from the perspective of the ubiquitous media paradigm, according to which content can be consumed regardless of the platform it is accessed from. Secondly, from the perspective of the second screen paradigm, according to which multiple devices are used at the same time, for performing either dependent or independent tasks.

One way of summing up ongoing converging trends is to consider these various aspects as the manifestation of Jenkins's vision. The old and new media have collided, and as a result new media genres have emerged. Interactive television is back on the agenda, mobiles are more than ever a critical player in media distribution, and tablets transform couch potatoes into active participants to UGC-based interactive shows. However it can be argued that not everything converges, and that convergence may not be the optimal model describing new media. Complementing Miller's predictions, a quick review of converging and diverging trends is discussed in the following.

Increased mobility

Recent evidence tends to show that technological convergence currently revolves around mobility. When considering mobile phones, the recent release of smartphones sporting quad core processors[1] and the likely following up of this trend in the coming months by other manufacturers[2] allows new generations of mobile devices to act as personal ubiquitous computers capable of supporting users in their context-independent, cross-platform, cloud-based multimedia life. This confirms earlier anticipations of the new role mobile phones would play in the ubiquitous media landscape. As mobile phones fulfil more and more functions, upcoming generations of devices can be expected to increase their role in people's everyday lives by granting access to an increased number of default services (such as banking or personal identification). Previously restricted to high-end models, phones' secondary functions such as high-speed Internet access and high resolution cameras become mainstream due to technology improvement and reduced costs, and are now equally important buying criteria as the communication features, taken for granted.

A number of converging media-related practices are also observable in ICT societies, for which mobile devices play an essential role. Media consumers now expect to be able to access content on any device, no matter which context they find themselves in. Until recently mobile phones were about "communicating with anyone at anytime and from anywhere", today's smartphones add the possibility to "access anything at anytime and from anywhere, and to share it with anyone". As one of the consequences of this "liquid" life, work and leisure activities are increasingly distributed across time and place. This explains why privacy issues are so important to tackle, as this is a big concern for end users. People want to use this distributed media infrastructure, which allow them to access all their "digital stuff" and share their online experiences with friends. However they also want to stay in control of who has access to what.

When it comes to watching television on-the-go, mobile TV is indeed being developed and can be expected to be soon a common feature. The most successful delivery method (broadcast, multicast, or streamed over IP) is yet to be determined, even if IP-based technologies seem to take the most attention at the moment. This technological advance however did not happen in the form of the revolution that was expected circa 2005. On the one hand, broadcasters see mobile devices as another content distribution channel, while on the other hand, end viewers expect to be able to watch media on their personal smartphones. Being able to watch live TV on a mobile phone is thus only the logical result of these tendencies reflecting maturing technology and evolving consumption practices.

[1] Such as the Korean version of Samsung Galaxy S III: http://www.phonearena.com/news/Samsung-Galaxy-S-III-gets-a-quad-core-version-with-2GB-of-RAM-only-for-Korea_id31033 (June 11th, 2012).

[2] *Nvidia anticipates 30 quad-core phones in 2012*: http://reviews.cnet.com/8301-19736_7-57441781-251/nvidia-anticipates-30-quad-core-phones-in-2012/ (June 11th, 2012).

By enabling ubiquitous access to one's digital world, smartphones essentially act as the converging point for work- and leisure-related activities while on the move. The tendency of these activities to overlap has been extensively discussed in recent literature, focusing on a variety of topics such as redefining the "elastic construction" of work and life (Cohen et al., 2009), the implication of homeworking (Wapshott & Mallett, 2012), or workers' attitude toward work according to their place of work (Redman et al., 2009). Closer to this thesis, the collapsing demarcation between work and leisure was the topic of a mini-study conducted during a course on "Audiovisuality in the era of digital convergence". During the exercise a number of course participants (students and lecturers) were interviewed about their strategies for separating work-related from leisure-related emails. The conclusions from the exercise are aligned with prior findings and show that despite attempts at keeping both categories of messages separated, most inboxes are used for a mixture of work and leisure activities. In addition to this, work and leisure are increasingly distributed across location and time, partly due to and certainly supported by mobile technologies. As a result, work and play can also be said to converge, in a way that let users manage the threshold between the two.

Personalization

An aspect of new media that can be said to diverge is personalization. People want the devices they own not only to fulfil the functions they are expected to enable, but also to make a statement about themselves either through a specific design, the secondary functions they support, or by allowing customization. A typical example is again the mobile phone, to which can be added physical accessories, customized ringtones, backgrounds, and applications. When looking at the design of recent mobile phones and especially smartphones, it has recently converged under the influence of major actors such as Apple. In response to the iPhone's worldwide success, other manufacturers have rapidly aligned their device design on a similar template. As Colton's saying goes, imitation is the sincerest form of flattery, although in the mobile world such practice is more likely to end up in patent infringement battles. Perhaps partly to escape this, and also to satisfy customers calling for diversity, the recent apparition of more "exotic" smartphone designs supports the claim that mobile phones are integrated into people's life to the extent that they act as an extension of the self and should therefore closely match public representation of individuals. For a long time less visible in other devices, this need for personalization also apply to today's TVs and perhaps more so to computers, which are now selected not only for their performances, but also their look-and-feel.

Content is also reflective of one's personality. Similarly to the diversification of niche TV stations focusing on specific genres or topics, online communities nowadays exist for virtually any interest. As an illustration, in June 2012 Wikipedia listed 199 social networking sites[3] dedicated to an incredibly diverse range of topics. By choosing to join and contribute to a number

[3]Wikipedia, *List of social networking websites*: http://en.wikipedia.org/wiki/List_of_social_networking_websites (June 21th, 2012).

of these online communities, people reinforce their individuality while contributing to the digital debate on subjects that matter to them. This attitude of picking personally relevant content from a vast choice of sources available is occurring online as much as in front of TV, where on-demand viewing and time-shifting are becoming more common practice. These practices however remain marginal, and flow TV is still by far the most common way of watching television today. Nevertheless, additional degrees of personalization integrating these practices and relying for instance on the paradigm of cloud computing are to be expected in the years to come.

Less flow, more interaction

In front of TV, audiences are now introduced to more engaging services, and some TV shows rely more on more on their input. Examples of such interactive shows are still rare, both in Japan and northern Europe. The examples cited in the previous chapters are still mostly trials, from which broadcasters not only gain experience with technology, but also test the reaction of viewers. According to these preliminary experiments, entertainment, news, and sports seem to be strong candidates for such new formats, perhaps leading to the definition of new TV genres. It is not to say that traditional, passive television watching is about to disappear, but in some certain cases, more interactivity is desirable and beneficial for both content providers and consumers.

In that regard, second screens are playing an eminent role in establishing a two-way communication between the production team and audiences. Interactive features accessible on tablets and smartphones offer access to further information about a topic discussed, or the possibility to send comments to contestant during a song contest, or to cast a vote for a poll. The information, traditionally travelling from the TV set directly to the viewer, is thus rechannelled via this second screen. For broadcasters, the balance between added value and experience disruption needs to be carefully considered in order to keep the audience focused on the content while deliberately shifting its attention away from the TV set. Early trials however successfully showed that guiding viewers through multiple devices during a live show is not only possible but also seems to result in a more dedicated audience.

While people welcome such new programme formats, television viewing remains a social activity among co-viewers, and the social interactions that take place in front of TV screens will not suffer from the introduction of second screens. On the contrary, these are expected to increase interactions also among viewers, for instance in cases of a family jointly participating in a quiz show at the same time as live contestants, and/or competing against remote peers.

Supportive broadcasters

Content providers such as large broadcasting corporations align themselves to the aforementioned evolutions. Acknowledging the superiority of the content delivered over the media it is delivered through, content providers are changing their delivery model to better integrate a wider range of platforms.

Additionally, broadcasters experiment with new interactive formats by taking advantage of social media platforms and the latest technology advances. For instance, the currently flourishing market of tablet computers offers new opportunities in terms of new content genres, engaging the audience with television shows. In fact, the popularity of tablets raises the question of whether such hybrid device (at the intersection between mobile phone and laptop computer) could be the converging point of media technology. Nevertheless, one should remember that all media platforms (radios, TVs, computers, smartphones, and tablets) play different roles in people's media life, and their usage tends to remain stable even when new devices enter the market. At home, the TV is still at the center of media attention, although it is surrounded by interconnected devices complementing each others.

What changes however is how devices are used. Similar to the radio with the advent of television, and the print industry when Internet became widespread, the way people watch TV is expected to change soon. Television's informative and entertaining roles remain important, however the way these functions are fulfilled could rely on a transformed TV compared to what we are used to nowadays. Looking at the USA for instance, cable TV subscriptions are currently dropping rapidly, as on-demand and time-shifted viewing progressively takes over flow TV. These trends are expected to follow in Europe and Asia, even though less imminently. On the one hand, since people are not as emotionally attached to their TV set than they are for instance to their phone, we expect this change to be little dramatic for end users. But on the other hand, broadcasters and other actors of the TV market should take actions to at least accompany if not guide this change. On example of potential transformation for television advocated by manufacturers is the implementation of additional features such as Internet-based applications directly into the device, supposedly turning it into a "smart TV". Indeed recent models support Facebook, YouTube, games, and other similar secondary functions accessible directly on-screen. However the combination of interaction issues (especially concerning data input) and the revelation of tablets as suitable companion to interactive TV services lead to believe that TV sets will most likely remain high quality displays with increased integration with its surrounding devices.

Cultural perspective

Cultural convergence is also happening, as visible in the new media environment in Japan and Denmark. Broadcasting corporations in both countries are undergoing structural changes and tackle the cultural gap between traditional media oriented mindsets focusing on newspapers, radio and TV, and new media oriented ones who try to push their corporation to fully embrace the paradigm shift toward the web and mobile. This contradiction in broadcasting corporations' management reflects the generational gap also observable in consumers, where younger generations (especially in Japan) tend to access Internet-based content primarily on their mobile devices, while older generation primarily rely on televisions, radios, and newspapers.

Technology adoption converges toward smartphones, currently more rapidly in Japan, although it currently stands far behind Denmark in terms of penetration rate according to Our Mobile Planet[4]. One potential factor explaining this difference is the definition of smartphones. Indeed the notion of smartphone in Japan is debatable, given the technological advances of feature phones, far more advanced than their western equivalent. The smartphone definition used by Our Mobile Planet is "*a mobile phone offering advanced capabilities, often with PC-like functionality or ability to download apps*". For what concerns mobile Internet access however, Japan is indeed more advanced in terms of number of users, and other regions are catching up.

Even though the two countries differ concerning their use and personal relationship with TV and mobile technology, similar trends are also observable. At home, Danes and Japanese alike place TVs and PCs at the center of their in-home media life. However it appears that mobile devices are used frequently also at home; although people tend not to consciously report it. This indicates that when reflecting on home media use, one might omit or lower the importance of mobile devices, which are not inherently dedicated to home settings. Confirming previous findings in other regions (South Korea), mobile TV is popular (or expected to be so) at home. Furthermore, a better integration of mobile devices with home media equipment is expected and desired. Two examples illustrating this, second screen applications generate much interest among early adopters and improved mechanisms for transferring content across devices are considered useful.

[4]Our Mobile Planet: http://www.ourmobileplanet.com (June 11th, 2012).

8.2 Revisiting the user researcher's toolkit

In order to identify the trends established in the first part of the thesis and summarized in the previous section, ten user studies were conducted, each adopting a different approach. The combination of these techniques generated a comprehensive set of qualitative and quantitative data, cross-validating each other and strengthening the individual findings from each study. As an illustration, Figure 8.1 plots the methods employed according to Rohrer's three dimensional classification scheme: Attitudinal versus Behavioural, Qualitative versus Quantitative, and the axis describing Context of product use. This latter dimension distinguishes *natural* from *scripted* use of the product, *not using* the product, and a *hybrid* combination thereof. In the case of the remote SMS prompting survey (study #7), the original intent to conduct a longitudinal field trial generating quantitative data eventually turned out to be more qualitative. Overall, the fact that half of those methods describe the lower left quadrant of the chart reveals the exploratory nature of the research project. This tendency is further demonstrated by the predominance of studies where either no product was manipulated by participants, or manipulated following a script, which denotes conceptual, early stages of the design process.

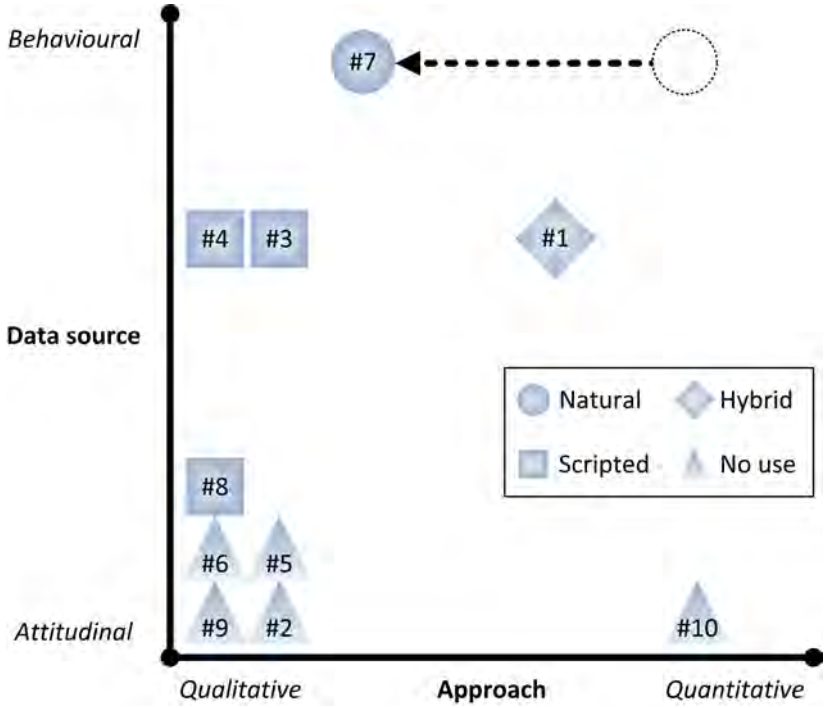


Figure 8.1: Classification of methods discussed in this dissertation according to Rohrer (2008).

This approach consisting of conducting multiple user studies to evaluate an issue from different perspectives, referred to as triangulation, is a traditional research strategy not necessarily ensuring data convergence, but

encouraging researchers to reflect on the underlying assumptions of their findings in case of inconsistencies or divergence (Mathison, 1988). The present thesis adopted triangulation at two levels. Firstly from a general point of view, the ten user studies informed the CAMMP project about the current status of end-user experience with converging media, tackling the field from diverse angles. Secondly, studying specific topics also implemented triangulation. For instance, the issue of second screens was examined through dedicated workshops, expert interviews, and an online survey. Similarly, the personal connection between users of TVs and mobile phones and these devices has been investigated through participant-based drawings, a drama-based workshop, and an online survey. The data gathered through those various means were found mostly converging, despite minor inconsistencies. In addition to this converging tendency, we argue that the pragmatic, mixed method research strategy adopted (as defined in Creswell (2003)), which consists in a mixture of qualitative and quantitative, attitudinal and behavioural, and varying contexts of product use, is a solid basis for affirming the validity of the conclusion reached throughout these studies.

Deciding upon which method to apply in the context of a large scale research project is non-trivial not only because of the large number of available methods to choose form, but also because this choice is contingent to the project interest at the time the study should be conducted. Fortunately, user research teams are increasingly included in the decision making process concerning the directions a project should take, and even though their influence depends on the projects scale and its internal dynamics, their input is used to inform the project directions. Eventually, the status of the project puts a certain set of restrictions concerning the range of methods to be applied, which somehow simplifies the choice of research strategy to adopt.

The influence of each studies on the elaboration of future test iteration is depicted in Figure 8.2. It shows that findings from the situated experiment (study #1) motivated the assessment of channel switching delays and the implementation of a longitudinal field trial, respectively studies #3 and #7. Similarly, some of the themes debated in the focus group on collaboration/competition were also addressed in the content transfer experiment and second screen workshops (studies #4 and #8). Later, the personal relationship with TVs and mobile phones first investigated through the participant drawings were further investigated in the drama-workshop (study #6) and the online survey (study #10). Some additional aspects of this personal relationship with media devices studied in the drama-workshop was further investigated in the online survey. Some topics discussed during the second screen workshops were also part of the online survey, and some of the expert interviews, some of which also influenced the workshops.

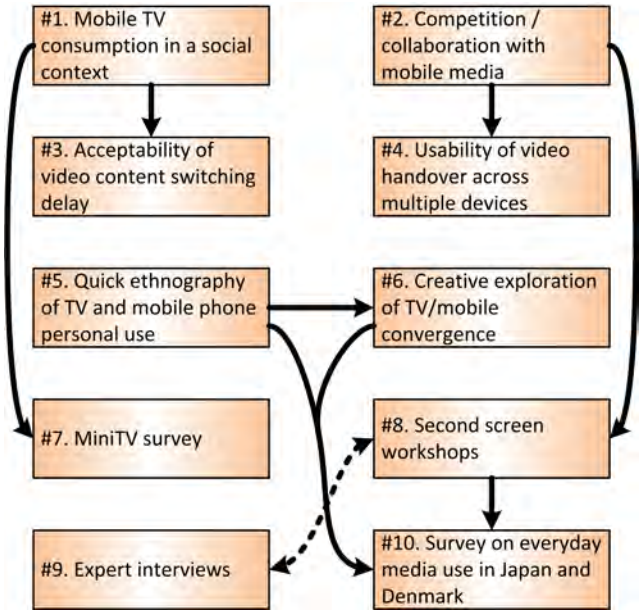


Figure 8.2: The influence of study outcome on the design of future experiments.

8.3 Results validity

In order to assess the validity of the findings put forward by the various methods used and thus to answer the sub-research question II.b (*How to ensure cost efficiency when addressing a wide range of issues related to user experience with converging media?*), we first consider the verification strategy devised by Morse et al. (2002) for ensuring reliability and validity in qualitative research. We applied this strategy to the second screen workshops (Fleury et al., 2012a), and we argue that this approach can be extended to the overall research strategy adopted in this dissertation. In the following we demonstrate how this strategy performed according to Morse et al.'s framework. This framework contains five principles, described as follows. The way these principles have been implemented throughout the research described in this thesis is also discussed.

Methodological coherence

For this the research team must select inquiry methods that are coherent with the research questions, even though the methods and research questions might evolve throughout the research. Throughout the research project discussed here, the individual research questions have been formulated at the same time as inquiry methods have been selected. Both influenced each other and occasionally led to either the modification of a research question, or to the redesign of an experiment.

Sample appropriateness

Participants recruited for a study should be knowledgeable about the research topic. The total subject sample for the ten studies reported here consist of 423 people, some of whom took part in multiple studies. All of them were usual media users, and most were demonstrated to be not only knowledgeable about converged media, but also representative of the target population for the CAMMP project: early technology adopters, media enthusiasts, and in majority young, referred to as *buzz* and *bling* users in Wieland & Thaarup (2011). In addition to representativeness, saturation (large enough sample) and replication (covering all aspects of the phenomenon under investigation) are also verified. Over 400 individuals from various demographic groups took part in studies covering a wide range of topics, including some redundancy for cross-validation.

Concurrent data collection and analysis

Iterating data collection and analysis ensures reliability and validity. The cyclic, iterative process adopted by the CAMMP project enabled results from all user studies to be considered and integrated in the decision making process driving the project. Data collection and analysis were thus tightly coupled.

Theoretical thinking

Similarly, the cyclic iterative process of the project allowed us to consider the data collected from a micro and macro perspectives. The intent is to vali-

date emerging ideas with data from the next iteration, from which the new ideas can be validated through the previous iteration's data. Ideas thus keep on being cross-validated as new data gets collected. This was illustrated in Figure 8.2, p. 234.

Theory development

Finally, theory should be developed as an outcome of the research process, by shifting focus during the investigation between micro perspective on the data and macro perspective on the overall concepts under study. This has visibly happened throughout the experiments conducted within this thesis, as illustrated by the shifts in their scope from conceptual to specific. This approach resembles the steps of grounded theory, as originally articulated in *The Discovery of Grounded Theory: Strategies for Qualitative Research* (Glaser & Strauss, 1967) and recently collaboratively updated in *Grounded Theory: The Philosophy, Method, and Work of Barney Glaser* (Martin & Gynnild, 2011). The data collected should be considered as a template for further theoretical development, by gradually categorizing the findings. In this thesis, we analysed the data first individually in each section of the thesis, and then from more holistic perspectives in the part summaries and general conclusions. As such, our findings thus participate in the refining of the theories behind media convergence, media-related HCI, and interactive television.

Performance analysis

In addition to Morse et al.'s framework, we propose here a subjective approach to quantify the performance of user research methods and apply it to the ones described in this thesis. To the extent of the analysis reported in this dissertation, applying the ten user research methods generated 447 individual findings (seven of which are common to eight studies and one of which is common to three studies, for a total of 498), formulated as statements and summarized in chapters 4 and 7. Out of the individual statements, 318 (71%) are results from the studies conducted, while 129 (29%) are conclusions regarding the application of the methods employed. The detailed distribution of all statements per study is provided in Table 8.1.

As summarized in Table 8.1, there are obvious discrepancies in the distribution of findings among the methods used. Additionally, some methods generated more statements about the study itself than about its results (and inversely some generated more result statements than findings related to the method). This naturally leads to question the interest of including the less productive methods in future projects. In order to assess this, the "quality" of the findings should also be questioned, as some findings might be more valuable from a research perspective than others. In that purpose a number of factors need to be considered, which can be formulated as the following questions. The rules according to which these questions have been applied to each finding are also provided.

Novelty Had the finding been established in previous literature, to the best of the research team's knowledge? Yes: 0; No: 1.

Table 8.1: Number of statements formulated per study.

Study	Study findings	Method findings	Total (%)
#1	18	18**	36 (7%)
#2	13	8*	21 (4%)
#3	2	13*	15 (3%)
#4	10	19*	29 (6%)
#5	34	27**	61 (12%)
#6	2	30**	32 (6%)
#7	21	21*	42 (9%)
#8	40	8*	48 (10%)
#9	85	0	85 (17%)
#10	93	36	129 (26%)
Total	318	180	498 (100%)

* Includes 7 common findings. ** Includes the 7 common findings and 1 additional one.

Dissemination Has the finding been disseminated through a peer-reviewed venue? No: 0; Yes: 1.

Internal validity Can the finding be easily influenced by experimental conditions? Yes: 0; No: 1.

Reliability Is the evidence backing up the finding solid? No: 0; Yes: 1.

Scope Can the finding be easily generalized to the target population? No: 0; Yes: 1.

We believe that these five metrics are well suited for estimating the quality of knowledge obtained from UX research. The following is an attempt at assessing the performance of the method we employed for each study based on these metrics. Tables 8.2 and 8.3 present how the methods scored according to each metric for the findings it generated concerning the study and the method itself, respectively. Note that the individual scores for *dissemination* and *internal validity* remain constant across all statements related to a method, hence the values being either 0.00 or 1.00 for these metrics. On the contrary the *novelty* of each statement is assessed individually, resulting in varying scores. Similarly for what concerns *reliability*, not all findings are equally backed up, for instance in case of disagreement between participants. In such cases the *scope* was also impacted, as weaker findings are hardly generalizable. Finally, *internal validity* and *scope* are deemed irrelevant for evaluating method performance. Indeed the former already relies on assessing the method, and the latter makes little sense as the methods have been applied only once each. In the following tables, the studies are ordered by decreasing order of *average* score, which reflects how each method performed on a 0-1 scale for the study- and method-related findings.

Finally, Table 8.4 presents the *study* and *method* scores, which correspond to the product of the average score established in the previous tables by the

Table 8.2: Scores attributed to each UX research method applied for the statements they generated about the studies.

Study	Novelty	Dissemination*	Internal validity	Reliability	Scope	*Average*
#4	0.90	1.00	1.00	1.00	1.00	*0.98*
#3	1.00	1.00	0.00	1.00	1.00	*0.80*
#10	0.70	0.00	1.00	0.98	0.98	*0.73*
#1	0.39	0.00	1.00	0.89	0.89	*0.63*
#5	0.76	1.00	0.00	1.00	0.00	*0.55*
#8	0.90	0.00	0.00	0.80	0.80	*0.50*
#6	1.00	1.00	0.00	0.00	0.00	*0.40*
#9	0.80	0.00	0.00	1.00	0.00	*0.36*
#2	0.69	0.00	0.00	0.00	0.00	*0.14*
#7	0.62	0.00	0.00	0.00	0.00	*0.12*

* The review process at the venue where the findings from studies #1, #2, and #7 were presented is light, and the publication of the results from study #8 is still pending. These studies are thus considered non peer-reviewed.

Table 8.3: Scores attributed to each UX research method applied for the statements they generated about the methods themselves.

Study	Novelty	Dissemination	Reliability	*Average*
#3	0.83	1.00	1.00	*0.94*
#5	0.63	1.00	1.00	*0.88*
#4	0.50	1.00	1.00	*0.83*
#8	1.00	0.00	1.00	*0.67*
#6	0.45	1.00	0.00	*0.48*
#1	0.40	0.00	1.00	*0.47*
#10	0.28	0.00	1.00	*0.43*
#2	1.00	0.00	0.00	*0.33*
#7	0.71	0.00	0.00	*0.24*
#9	-	-	-	-

number of statements the study generated. This allows to distinguish between methods that obtained a high score yet generated a limited number of findings from the methods that obtained a lower score but generated many findings. The *total score* is the sum of these two scores. Note that the maximum possible score for each method is the number of findings it led to discover.

Interpreting these scores requires some precaution, as it is based on estimates and the validity of the metrics used is unverified so far. One metric obviously missing in this analysis is the impact factor, which can be measured for instance by citation counts of the publications, and by the further interest about the topic in the research community. We will only be able to measure this at a later point in time. Nevertheless, according to the previ-

Table 8.4: Summary of how each method performed at generating study- and method-related findings, and the sum thereof.

Study	Study score	Method score	**Total score**
#10	68	15	**83**
#5	19	24	**43**
#9	31	-	**31**
#4	10	16	**26**
#8	20	5	**25**
#1	11	8	**19**
#6	1	15	**16**
#3	2	12	**14**
#7	3	5	**8**
#2	2	3	**5**

ous analysis, the WOz approach (study #4) appears the most suitable method when it comes to generating findings, while the lab-based usability evaluation (study #3) obtained the best score regarding the method itself. However when considering the number of findings each method put forward, the cross-national online survey (study #10) scored best and by far, followed by the drawings (study #5) and expert interviews (study #9). On the contrary the focus group on collaboration and competition issues (study #2) and the remote SMS prompting (study #7) performed poorly according to this scheme. Overall these conclusions reflect well the subjective assessment of the methods by the research team. Study #7 was indeed disappointing as it turned out very differently than originally envisioned, and study #2 generated a limited amount of knowledge. The good performance of the drawing-based study is encouraging and reflects a very positive opinion from the research team on this particular method. Even though this approach to performance analysis requires more thorough evidence of its validity and usefulness, it is thus argued to be a first step in objective evaluation of use experience research methods.

Cost analysis

The following extends the previous discussion and analyses the cost of including each research method in the research project. First of all, it is important to acknowledge that this type of analysis, similar to the previous one, is subjective, imprecise and highly project contingent. Nevertheless as the costs related to pursue the best user experience in technology products are still a barrier for many companies, we argue that empirical attempts at formalizing UX cost analysis are essential.

So far, most of the research on return on investment (ROI) related to user research is dedicated to usability. For instance in *Usability Engineering*, Nielsen enumerates a number of projects during which following usability principles saved costs to the organization developing a new product (Nielsen, 1994b, pp. 2-3). Later on, Nielsen argues that the cost of fixing usability-related problems of a product once it is on the market is a hundred times more expensive

than fixing them at an early design stage, hence justifying the benefit of integrating usability principles early in the design process. Summarizing previous findings on this issue, Rosenberg (2004) debunks six popular myths related to usability's ROI. The following lists some of the commonly accepted benefits of usability, and more generally of human factors, driving internal ROI (saves the organization money throughout product development), external ROI (increases the profitability of products), and social ROI (perceived benefits, affecting internal and external ROIs) according to Marcus (2005) and Shaver & Braun (2008).

Increased

- Ease of use
- Ease of learning
- Satisfaction, trust, and loyalty
- Repeat purchases
- Purchase recommendation
- Safety and health
- Productivity and work quality
- Satisfaction and commitment
- Sales and market share
- Stock value
- Brand recognition

Decreased

- Accidents, injuries and illnesses
- Lost workdays
- Error rates
- Training time
- Absenteeism and turnover
- Development costs
- Need for redesign and recall
- Support and service costs
- Labour costs
- Equipment damage
- Maintenance costs
- Insurance rates

Measuring the actual effect of applying user-centred methods to product development is however tedious, hazardous, and prone to inaccuracies. Nevertheless, empirical knowledge in this area is essential in order to objectively assess the cost-benefits of UCD. In the present case, we assessed the costs of the methods by allocating them points according to three-level scales (from 1 to 3, plus 0 when non-applicable) describing the following four criteria. The validity of these criteria, their ability to describe UX costs, and how the points are attributed are necessarily debatable and call for further attention. Additionally, these criteria are relative to the studies described in this thesis; additional methods might thus be off scale.

Team The number of people involved full-time in the development, conducting, and analysis phases of the project. Fractions are used in case of partial involvement. Points are attributed by dividing the range from minimal to maximal value equally.

Material This scale describes the direct cost of buying equipment, rewarding participants, and travelling. Points are attributed according to the 25^{th} and 75^{th} percentiles (inclusive), to limit the effect of large variations.

Development This scale represents the effort required to generate the equipment for the experiment. Points are attributed as follows.

1. No prototype, existing product requiring no adjustment, or limited office material (such as pens and answer sheets)
2. Low-fi prototype, existing product requiring little adjustment, or advanced office material
3. Hi-fi prototype, or existing product requiring many adjustments

Time The duration of preparation phase and the effort required for conducting the test. This metric is arguably the most subjective one among those chosen, as task allocation is hard to keep track of during research projects due to temporal fragmentation and multitasking. Points in this category are thus attributed according to the research team's perception.

The result of applying these principles is provided in Table 8.5, in which methods are ordered in increasing total cost. As can be seen, the drawings (study #5), the remote SMS prompting (study #7), and the expert interviews (study #9) are the least expensive methods, while the workshops about second screen (study #8) led to the most spendings.

Table 8.5: Cost grades attributed to each methods applied during the research project.

Study	Team	Material	Development	Time	Total
#5	1	2	1	1	5
#7	1	0	2	2	5
#9	1	2	1	1	5
#1	2	1	2	2	7
#2	2	1	2	2	7
#10	1	2	2	2	7
#6	1	3	2	2	8
#3	2	2	3	3	10
#4	2	3	3	3	11
#8	3	3	3	3	12

The final step in this analysis consists in comparing the performance/cost ratio, as presented in Table 8.6. This indicates that the online survey (#10), the drawings-based studies (#5), and the expert interviews (#9) are the three most cost-efficient user research techniques employed in the course of this work. On the contrary, the cost of conducting the focus group on collaboration/-competition (#2), the usability study about channel switching delays (#4), and the remote SMS-based survey (#7), are less obvious to justify in the light of this analysis.

Table 8.6: Performance/cost ratio of each UX research method.

Study	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
Ratio	2.5	0.5	1.5	2.5	8.5	2.0	1.5	2.0	6.0	12.0

Final draft

CHAPTER 9

CONCLUSIONS

9.1 Answering the research questions

The user studies conducted throughout the work reported in Part I of this thesis help answer the first research question I and its related sub-questions I.a and I.b. Similarly, analysing the methodology adopted to conduct those studies in Part II and performing their performance/cost ratio allows answering the research question II and its related sub-research question II.a and II.b. The following paragraphs specifically answer the research questions and related sub-research questions by citing the chapters and sections tackling them.

I. *What are the current and near future trends in converged media, seen from the perspective of Danish and Japanese media consumers?*

Starting with observing the evolution of the mobile television ecosystem in the two regions demonstrated the complexity of the current new media field. It also helped identifying factors expected to play a major role in reshaping the future of converging media. These factors are shortly described in the following.

- New media consumption habits observed among early adopters will inevitably become more widely adopted in the months/years to come. These emerging patterns include platform independence for media consumption and service personalization, as further detailed below this list.
- Wireless Internet as a commodity enables ubiquitous access to media and services regardless of time or spatial constraints.
- Tablets being at the crossing of personal mobile devices and shared computers, bring about an opportunity to service providers for developing a new segment of home media applications.

- Internet TVs enable real-time interactivity between content owners and end viewers, who will have the possibility to participate in TV shows.
- Multiscreen viewing not only alleviates issues with concurrent viewing, but also enables ubiquitous access to media content, as well as bidirectional communication between content owners and their audience.

Taken together, these five factors support the prediction of the following five general trends for the near future in terms of converging media from a user point of view.

Increased device independence The platform used for consuming media will become increasingly transparent, meaning that end users will access media content on whatever platform is at their disposal or they deem most relevant at the time. This was mostly visible through the situated interviews, the remote survey, and the content transfer experiment.

More personalization Not only media devices will increasingly act as extensions of the self and reflect their owner's personality and representational style, but media services will be increasingly tailored to end viewers in terms of content and distribution. The primary source for this trend were the studies exploring the relationship between mobile phones and their users (the survey, the drawings, and the drama workshops), as well as during the second screen workshops.

Rise of interaction, stability of flow Based on successful early trials, more TV shows will offer the audience a possibility to directly interact with the content of the show, by means of voting, commenting, or interacting with participants and other members of the audience. This was deduced from the interviews with R. Furukawa, J. Wieland, J. Winbladh, the second screen workshops, and the cross-cultural survey. Yet, as specifically discussed with J. Wieland, and as indicated by the workshops and survey, flow TV will remain favoured for certain types of shows and within certain watching contexts.

Supportive broadcasters As it was explained by R. Furukawa, J. Wieland, J. Winbladh, content providers will continue renewing some of their content formats to include interactive features and in doing so supporting the increasing call for direct public participation.

Global phenomenon The cross-cultural studies (namely the survey and the drawings), as well as the interviews indicate that the aforementioned evolutions are expected to happen almost simultaneously on a global scale among ICT advanced countries, even though minor cultural specificities will reside.

In addition to identifying trends, Chapter 2 investigated more specifically how technological and cultural factors might affect broadcasters' and end users' attitude toward new media, which is the focus of the following sub-research question I.a.

I.a ***How the technological and cultural aspects of media convergence affect broadcasters' content distribution strategies and end users' consumption practices?***

Affect on broadcasters The rise of new consumer technology and new media consumption patterns among the public drive broadcasting corporations to adapt both the content they deliver and how they deliver it. One current trend among broadcasters is to recognize the multitude of personal media devices (smartphones and tablets) on which their content is accessed and to integrate such devices into the content delivery process. Audiences can now not only switch from a device to another depending in their immediate context, but can also access various types of content related to a show depending on the platform they use.

Affect on end users Similarly to broadcasters, media consumers are affected by technological advances and culturally-driven practices. For instance, second screen practices are expected to rapidly spread among TV viewers, benefiting from the rapid development of tablets and their increased penetration to the households. Such technology seem to have found its place in the living room, as a companion to the main TV screen. However technological advances and adequate cultural background does not always result in innovation successes, as seen for instance with mobile TV. Its wide availability combined with Japan's strong mobile media adoption created only little interest in the service, and similar stories have been witnessed in Europe. The following subresearch question further explores the impact of these changes on end users.

I.b How do Danish and Japanese media consumers perceive the convergence of television and mobile technologies, and what are the opportunities and challenges for wide user adoption of services resulting from such convergence?

Mobile / TV convergence The studies investigating the personal relationship between media technology (phones and TVs) and end users (namely the drawings, the drama workshop, the second screen workshops, and the survey) show that the combination of television and mobile technology benefits from both the very personal character of mobile phones and from the shared condition of TVs, and of the different roles attributed to each (e.g. communication versus information). On the one hand, some media consumption is becoming increasingly tight to individual preferences and activities, while on the other hand, media consumers are increasingly bound to content providers and fellow consumers by way of community platforms and direct communication channels.

Opportunities and challenges All the studies reported throughout Chapter 3 participated in discovering potential opportunities for new or improved media services. In particular, second screens should rapidly become companions to the television experience. Additionally, social communities (for their bounding and sharing aspects) and games (for their motivation and reward aspects) are expected to be valuable sources of inspiration when it

comes to rethinking the relationship between media content and end users, and developing new genres of content.

The remaining challenges uncovered in this thesis that needs to be to tackled are mostly of a usability nature. Transition delays between TV channels when perused on a mobile device, and methods to transfer media content across devices are two typical examples of such usability challenges. The issue of content synchronization across devices is highly relevant not only for end users but also for broadcasters, as future successful second screen services will heavily depend on such good timing.

While the first set of research questions considered the results from various user studies, the second research question and related sub research questions focus on the methods employed to carry those user studies, as elaborated on next.

II. How to optimize the evaluation of user experience with converged media through a mixture of qualitative and quantitative methods in the context of a 4-year platform project?

In order to properly investigate a complex ecosystem spanning across various disciplines and involving numerous actors, it is recommended to adopt a triangulation-based research strategy. The same applies when focusing on user research within such ecosystem, as demonstrated throughout this thesis. The methods employed to investigate user experience with converging media covered various data sources and approaches, respectively from attitudinal to behavioural and from qualitative to quantitative. Additionally, it is recommended to introduce prototypes for some studies and to reproduce various levels of naturalistic conditions of use with them. However, relying solely on prototype evaluation might result in overlooking critical aspects of UX, such as personal clues as discussed for sub research question II.a. Thus prototype-free methods should also be included in the research strategy. Furthermore, the performance over cost ratio in employing various user research methods should be considered, as further discussed in the context of the sub research question II.b.

II.a How to discover personal stories related to media practices in multi-cultural settings and with tight time constraints?

Accessing personal stories from user study participants can be achieved in various ways, and the purpose of this research question is less to argue for the best approach than to present alternatives to largely popular methods such as in-depth interviews or diary studies. As developed in Section 3.1, participant generated drawings and introspection-based exercises as those performed individually during the drama workshops uncovered personal facets of user experience with media technology in a relatively short time. In particular the participant generated drawing, despite a need for refinement, is argued to offer UX researchers a powerful and efficient tool to access personal stories, even among participants of various cultural backgrounds.

In addition to drawings, and focusing less on personal stories and on the multicultural and efficiency constraints, the survey and expert interviews conducted during the research reported in this dissertation have generated a large amount of valuable data in a timely fashion and at a low cost, as further explained in the case of the following and last sub research question II.b.

II.b How to ensure cost efficiency when addressing a wide range of issues related to user experience with converging media?

We argue that the framework proposed in Section 8.3 enables assessing the performance of user research methods applied to a research project relative to their cost in a relatively objective fashion. Such evaluation methodology is foreseen to be useful to the UX research community not only for reviewing the performance of a research strategy at the end of a project as it has been the case in the present work, but also for planning such strategy at the early stages of user centred projects.

9.2 Limitations and perspectives

As a final contribution to this research project, this section acknowledges the limitations concerning the scope of the conclusions drawn from the user studies reported. As we recognise that only careful examination of the boundaries of a research project may lead to qualitative improvements, we identify a number of potential action points for researchers interested in elaborating on the present work.

Scope

The work reported in this dissertation clearly focuses on Europe and East Asia. While cultural comparisons were not the purpose of this research, shedding light on other markets would uncover aspects of user experience with converging media that might have been under- or overlooked in our work. In particular, the remarkable development of cable television in the USA has led to a TV market highly different from the European and East Asian ones. Additionally, emerging ICT markets are rapidly catching up with established leading markets by stepping over development steps, for instance by directly deploying cutting edge mobile infrastructures and services. These are but examples of market specificities not addressed in this thesis, and a plethora of similar considerations exist. Yet studying how cable TV has shaped media consumption in the USA and how mobile technology is being deployed in emerging markets would constitutes a natural future step for scholars interested in the development of new media worldwide.

Width versus depth

Considering the first part of the dissertation, we argue that the work reported is less groundbreaking than groundsetting, that the overall contribution of the study results are more conforming than disruptive. The work presented has been faithful to its theme of convergence, as it aimed at combining various research traditions to explore the vast network of intertwined research directions related to new media technology. This led to the identification of upcoming trends concerning user attitude toward new media. Especially in a young and rapidly evolving area such as converging media where new, potentially game changing technology constantly emerge, researchers ought to take a step back and reflect on how such innovation may affect its targeted users. Focusing on end-users automatically places researchers in a gray area where findings reflect the diversity of ICT users, and are thus not always statistically quantifiable.

Applying a mixed-method research approach strengthens those findings, as demonstrated in the second part of the dissertation. In addition to the voluntary application of various research methods for this purpose, the cyclic, iterative process of the CAMMP project encouraged the investigation of a wide number of topics. Concretely though, the transition between iterations reflected shifts in interest from all partners, and thus conducting direct follow up experiments to further investigate issues arising from the study was hard to set up. As a result, despite the wide scope of the research conducted and

the consideration of a large number of issues and perspectives, a logical criticism that can be addressed is a seemingly lack of depth. The conclusion of such research thus logically leads to more questioning of the data collected, as summarized in the following section.

Study participants

Another potential limiting factor is the demographics focused on. One might object that early adopters are not representative of a population, even a well developed one ICT wise. Although we reckon this argument, we however argue that technology enthusiasts are well suited for the main purpose of the research reported here, concerned with the identification of upcoming trends related to new media. Early adopters are indeed critical when studying new technology, as they are the ones setting trends and ultimately driving adoption. We also reckon that based on the conclusions reached after studying this population segment, one might want to see how other segments would react to the realization of the trends identified. One potential segment is the older population, for which radio, TV, and print remain the main sources of information and entertainment. For instance HCI researchers studying the feasibility of iTV features for the elderly could benefits from what we have learned with early adopters. Another obvious segment to target with such innovation is the younger population and especially teenagers, who are particularly fervent users of communication technology and are expected to provide valuable insights on for example how media devices could be better integrated and supportive of on- and offline social networks.

Performance/cost analysis

The performance and cost analyses conducted in Section 8.3 are an attempt at systematizing the evaluation of user research methods. The way it has been conducted here however suffers from two potential weaknesses: subjectivity and incompleteness. The 447 findings enumerated are based on my own reading of the thesis, and thus the amount of statements compiled for each method is arguable. Even though one might argue that the only findings to be considered are the ones disseminated and are thus taken into account here, more thorough analysis of the data from individual studies by at least one external person would be required to provide a more exhaustive and objective set of findings. Such strategy could easily be implemented during future research projects. This would require the research team to establish a complete set of results and costs associated with their studies, and engage an external person to evaluate them according to the criteria selected. Regarding that matter, the list of criteria deemed relevant for this thesis need to be recognized as suitable to evaluate performance and costs of UX research. Finally, when attempting to use such framework to plan a research strategy at the onset of a project, it might be difficult to estimate the amount of findings that a particular method will generate. One way of tackling this issue would be to consider such amount as equal for all studies, while another approach would be to generate an estimate based on previous similar studies.

These remarks conclude the thesis. We hope that the research reported throughout those pages have provided the reader with a comprehensive perspective on current and near future trends happening in the active fields of new media, and user experience evaluation thereof. In constant and rapid evolution, new media technologies need to be carefully evaluated with its potential end users in order to develop desirable and enjoyable products. We believe that the few directions explored in this dissertation will be of particular relevance in the months and years to come, and the the work presented here contributes to forming the basis of future research in human-computer interaction for new media.

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Appendices

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FLEURY ET AL., 2009

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Two perspectives on mobile television: Consumption in a social context and Collaborative/competitive behaviors

Alexandre Fleury
Aalborg University
Niels Jernes vej 12
DK-9000 Aalborg Denmark
amf@es.aau.dk

Jakob Schou Pedersen
Aalborg University
Niels Jernes vej 12
DK-9000 Aalborg Denmark
jsp@es.aau.dk

Lars Bo Larsen
Aalborg University
Niels Jernes vej 12
DK-9000 Aalborg Denmark
lbl@es.aau.dk

ABSTRACT

This paper describes two user studies aiming at uncovering two distinct aspects of end user experience with mobile television. The first experiment assessed the acceptability of using mobile TV services in a public context, while the second experiment investigated the test users' collaborative and competitive behavior as a possible motivation factor to encourage user contribution. The results from the first study suggest that users would feel comfortable watching mobile TV in a social environment, especially when combined with earplugs. The second study uncovered challenges to tackle in order to achieve mobile collaboration and that the trustworthiness of mobile services is of primary importance for users willing to contribute with content.

Keywords

User studies, situated test, panel discussion, mobile tv, social environment, collaboration, competition

1. INTRODUCTION

1.1 Context of the study

The work reported in this paper takes place in the context of the Converged Advance Mobile Media Platforms (CAMMP) project[1] and addresses the convergence of media services with mobile technologies. In this purpose, CAMMP merges 3G mobile technologies with Internet, digital TV and radio and investigates the potential of this new infrastructure which combines traditional media and user-generated content.

1.2 Motivations

The CAMMP project offers a unique opportunity to design, implement and test new mobile rich media services. Especially because the project is still in its early phase, it is crucial to identify the target population, its willingness to use such services and its expectations towards it. This is the aim of the first part of the work presented in this paper. It investigates one of the first contexts of use for mobile TV to be thought of, namely a social environment where the user has to deal with more than what happens on the screen of the device. Additionally, the population recruited for the test is composed of "early adopters", which includes the first end users of new technology and services.

The main motivation for conducting the second part of the study comes from the lack of literature in the areas of mobile collaboration and competition. Human collaborative and competitive behaviors have been extensively studied in many contexts and from various approaches, but the available research does not appear to focus much on mobile settings. It is therefore interesting to investigate firstly how users perceive these two notions put in a mobile context and secondly if these behaviors could be used to motivate user-generated content creation. Moreover, research on motivation factors for user contribution has primarily focused on online services accessed from fixed platforms. Therefore, only some of the conclusions might apply to mobile online services.

[1]http://www.cammp.aau.dk/

1.3 Outline

Section 2 presents previous research work conducted within the topics covered by the presented studies. Then, the two test activities of interest, namely the social interaction study and the conceptual evaluation are detailed in sections 3 and 4, respectively. The main findings for each activity are presented in the according section. Finally, Section 5 concludes on the paper's contribution and opens for further research.

2. RELATED WORK

The related research referred to in this section should be seen not only as an introduction for the work presented later in the paper but also as a grounding material for future research in the areas discussed.

2.1 Consumption contexts

When dealing with the consumption of mobile media in a social context, the study reported in [1] identifies the following classification of social motivations for watching videos on mobile devices:

- Individual Viewing
  - Managing solitude
  - Disengaging from others
  - Managing transitions between spaces
- Coordinating mobile experiences with family life
  - Juggling commitments
  - Coordinating content with family
- Watching at home
- Sharing the experience
  - Watching together
  - Showing video to others

- Owning and exchanging content
- Getting content onto the devices

The social interaction study presented in this paper focused on practices related to "individual viewing" and "sharing the experience".

2.2 Competitve behavior

Analyses of human competitive behavior have been carried out by many researchers, a number of whom focused on gender issues. For instance the authors of [2] investigated the differences in behavior between women and men when choosing a payment scheme. The results show that men are more likely to choose a competition-based payment scheme (where the highest benefits go to the best performer) than women, who are influenced by their degree of risk aversion. Men on the other side compete more against other men than against women. Furthermore, Rizza and Reis focused on women's competitive nature and presented in [3] a study on how competition impacts school girls in their academic and personal lives. The interviewees reported a negative perception of the term competition and preferred to use "comparison" instead. However, in this particular setting competition as such was perceived as achieving both positive or negative sociocultural results.

When it comes to using this competitive behavior as a motivation factor for online user contribution, von Ahn presented in [4] the principles of "games with a purpose", which consists in creating games which solve computational problems that cannot be solved by electronic systems. This approach has been named "human computation" and is introduced in [5]. For instance [4] introduces two examples of small online games which use this principle. The first game, called the "ESP Game"[2] serves the purpose of image labeling while the second game, "Peekaboom" addresses exhaustive image description through locating objects in pictures.

2.3 Collaborative behavior

As for its competitive counterpart, the study of human collaborative behavior can be carried out from various perspectives. For instance Semmann documents in [6] his research on human cooperative behavior in a large group of unknown individuals. He demonstrates that humans naturally cooperate only under certain circumstances such as reputation building. Despite this rather negative conclusion, Semmann demonstrated that optional participation could sometimes promote voluntary and anonymous participation.

In another study, Tyler and Blader reported in [7] that the main antecedent for cooperating in a social group is the notion of identity. Maintaining a favorable image of oneself and of the group appears of primary importance and influences the group members' behavior.

Furthermore, motivational factors have been described in various setups with existing services. For instance [8] and [9] investigated the practice of tagging pictures using web-based photo sharing platforms like Flickr. While Ames and Naaman defined a taxonomy of tagging motivations along the sociality and function axes [8], Nov et al. report that the motivation to tag for the general public or oneself is positively correlated to the number of tags, whereas it is not the case when it comes to tagging for family and friends [9].

Finally, [10] assesses social psychology theories as a driving tool for encouraging user participation in online communities. Reminding the contribution's uniqueness to their creator as well as assigning challenging goals seem to be an efficient way of ensuring user contribution.

[2]www.espgame.org

3. SOCIAL INTERACTION STUDY

3.1 Presentation

The purpose of this activity was to investigate how users handle the consumption of rich media in a social context. We carried out this investigation through a situated testing approach in which test users were observed while consuming rich media in a live and natural context (e.g. while situated in a canteen). Immediately after, they were debriefed via semi-structured interviews.

3.2 Test setup

The evaluation took place in one of the canteen areas at Aalborg University, between morning and early afternoon (roughly between 10.30 and 13.30) i.e. when there were other people in the canteen. All participants were interviewed for approximately 30 minutes each. The tasks performed by the participants were carried out on Nokia N77 phones, receving a DVB-H signal from a local broadcast setup. The test environment is illustrated in Figure 1.

Figure 1: The canteen as test environment for the social interaction study

3.2.1 Tasks to be carried by test participants

During the test session, each participant carried out the following set of tasks, while being asked a set of related questions.

- Start up the TV-player application on the device.
- Surf the available channels.
- Tune in on the news channel and watch two full news stories; also pay attention to a textual news ticker located at the bottom of the screen.

3.2.2 Participants

In total 26 participants were recruited (3 females and 23 males). As means of compensation, all participants received a food-voucher to be used in the canteen. The participants

were recruited among students and staff from Aalborg University. The participants were 24.2 years old in average among who 21 expressed a high level of IT literacy. Four reported a moderate level, while only one reported a low level (although this participant reported being more comfortable with mobile phones than with computers).

3.3 Main findings

Interviewed users reported a strong willingness to watch mobile TV in social contexts, especially outside the home in situations of static mobility (e.g. public transports). Commuting hours and evening were the most envisioned time of usage. News was clearly the most cited type of content to be watched, in order not only to stay up-to-date but also to kill time. Most participants reported foreseeing to be comfortable when watching mobile TV in a public context, especially among strangers, although they would use earplugs when doing so. Furthermore, it has been repeatedly reported by test participants that the practice of watching TV in such context is similar and comparable to the practice of reading the newspaper or listening to music. For what concerns their experience with the mobile TV solution on the Nokia N77, they reported a very positive first opinion, especially with the image resolution. Complaints were however reported concerning long delays when switching channels.

4. CONCEPTUAL EVALUATION

4.1 Presentation

The purpose of this activity was to investigate the concepts of competition and collaboration which are involved by the use of rich media services in a social mobile context. Informal panel discussions were used for elucidating these issues. Each panel discussion started with a brief introduction of the CAMMP project and its scope, which was followed by the illustration of the two concepts of focus (collaboration and competition) through real-world examples. A selection of scenarios were used as examples of possible concrete applications where collaboration and/or competition are involved. In these scenarios, the collaboration scheme is to be interpreted as an implicit behavior: users collaborate with each other mainly through the use of the service, in opposition to direct collaboration where users would team up prior to interacting with the service. Additionally, a realistic collaboration-oriented scenario was acted out by the participants themselves. The scenario required the group to identify a preferred movie from a selection of video clips. Gathering the participants' input was be done through notes taken by the test facilitators as well as video recording of the test session.

4.2 Test setup

For the panel discussions, three groups of three, three and five participants were formed. The sessions took place in the afternoon and lasted approximately two hours each. All participants were paid in form of cinema tickets. The test setup is illustrated in Figure 2.

4.2.1 Participants

In total, 11 participants (10 males and 1 female) took part in the conceptual evaluation. The participants had an average age of 25 years and were, according to themselves, either moderately or highly skilled within IT (Moderately: 6, highly: 5). Based on questionnaires filled out by the participants prior to the conceptual evaluation, 72% of the participants tend to display collaborative behavior as belonging either to the group of "Creators" or "Critics" (according to Forrester's online consumer segmentation model [11]). It could therefore be speculated that almost 3/4 of the participants would be likely to contribute either with data to a platform based on user-generated content or with comments, ratings, reviews etc. to such a setup. It should however be noted that this tendency may be coupled to the relatively high IT-literacy of the participants.

Figure 2: A meeting room as test environment for the conceptual evaluation

4.3 Results

Two thirds of the interviewed users displayed, through a collaboration scenario, explicit collaborative behavior involving verbal communication. The users reported that during such explicit collaboration involving mobile devices, issues such as omnidirectional sound and synchronization between sound/video as well as between devices could by quite annoying. The general quality of the tested handsets (Nokia N77) as well as video content broadcast via DVB-H was however praised. It was furthermore stated that while discounts/micro rewards may motivate some users to contribute with data it would potentially also open for abuse and lead to situations of untrustworthy information. It was suggested that a high level of quality in the information available may motivate users to contribute with additional data and that feedback to contributions may be highly motivating. For what concerns driving forces for competition it was indeed found that high score functionalities would be important, especially when among friends. In order for users to be willing to use competitive services it was in addition argued that user settings should be centralized in order to make for instance gaming on various devices as convenient as possible. Also, the interoperability between all kinds of mobile terminals should be guaranteed for the same reason.

5. CONCLUSION AND FUTURE WORK

5.1 Contribution

This paper presents two user studies dealing with specific aspects of the user experience with mobile rich media services, namely the use of mobile television in a social envi-

ronment and the perception and application of collaborative and competitive behaviors with mobile rich media.

The findings from these studies suggest that early adopters have no problem neither watching informative and entertaining television programs on their mobile device in a public context, nor dealing (consciously or not) with the concepts of collaboration and competition when applied to mobile setups.

5.2 Future work

With regard to the context of use, the answers from the interviewed users could be mapped to the classification scheme introduced by O'Hara et al. in [1]. Furthermore, later studies could complement this initial mapping and provide a more complete and reliable model of the targeted population's habits in terms of mobile media consumption.

These further studies could be integrated into CAMMP's next test iteration, which will include a large scale field trial. It is envisioned to provide compatible mobile phones to a large representative segment of the Danish population and record their usage over a period of several months. This will validate the initial results concerning the context of use of mobile TV.

Foreseen future user tests include:

1. **Determining the acceptability of channel switching delays.** It is to be assessed how tolerant users are when it comes to channel switching delays.
2. **Further investigating motivational factors for contribution.** It is to be further established how end users can be encouraged to produce multimedia content as well as ratings, comments and/or reviews.

Building on the preliminary results presented in this paper, this last test would provide a better understanding of how to encourage end users to participate in the mobile TV community through user generated content. Beyond this, it would also inform future service designers on the users' inner motivations for using a particular service. Indeed, it has been recurrently discussed during the conceptual evaluation that the added value to mobile media services such as mobile TV are community-like practices such as reviews, comments and ratings. Therefore, understanding the motivational factors for user generated content should be integrated to future mobile media services.

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Final draft

PUBLICATION B

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Final draft

Acceptable Channel Switching Delays for Mobile TV

Alexandre Fleury
Aalborg University
Niels Jernes vej 12
DK-9000 Aalborg, Denmark
amf@es.aau.dk

Jakob Schou Pedersen
Aalborg University
Niels Jernes vej 12
DK-9000 Aalborg, Denmark
jsp@es.aau.dk

Lars Bo Larsen
Aalborg University
Niels Jernes vej 12
DK-9000 Aalborg, Denmark
lbl@es.aau.dk

ABSTRACT
This paper presents a user study investigating the acceptability of channel switching delays on mobile television systems. The authors first review the previous work in the area, then propose a study design and present results from its implementation, focusing on the overall acceptability threshold as well as three potential effect factors: the transition type, the test environment and the audiovisual content. The results show that delays longer than 5.7 seconds annoyed test participants, and that the transition type had a significant impact on the rating of channel switching delays. However, neither the test environment nor the audiovisual content influenced the ratings significantly. Finally, a discussion of these results and directions for future research are proposed.

Categories and Subject Descriptors
H.5.2. Information interfaces and presentation: User interfaces – *Evaluation/methodology*.

General Terms
Measurement, Performance, Experimentation, Human Factors, Verification.

Keywords
Mobile TV, channel-switching delay, user studies, simulated environment.

1. INTRODUCTION
Traditional analog television allowed switching channels almost instantaneously. Quite surprisingly from a user perspective, despite the great improvement in terms of video quality, digital IPTV technology suffers from a noticeable latency when changing channel, due to various technological constraints [13].

For what concerns mobile TV, a lot of focus has been placed on various usability matters [1]. However an open issue still exists regarding channel switching delays. Providing low response times comparable to those known from analog TV is important, but the definition of 'low' remains unclear. The time and cognitive resources allocated to watching television on the move are limited and differ from those available when watching fixed television, i.e. on a stationary set at home. Furthermore, users do not like to wait for neither the service to load on their mobile device nor for the channel to switch when requested [2].

EuroITV'11, June 29–July 1, 2011, Lisbon, Portugal.

In this paper we therefore address the unresolved usability issue of acceptable TV channel switching delays on mobile phones.

1.1 Outline
In the next section, we provide an overview of previous research within TV channel switching delays. We then detail our study design, methodology and results for our conducted experiment, before discussing the results and applied methodologies. Finally, a general conclusion summarizes the findings and discussions, and opens for potential future work.

2. PREVIOUS WORK
A general human-computer interaction rule concerning response times is that a system should respond to a user input in less than 1 second in order to provide a continuous experience with the system without losing his/her flow of thought [10] (p.135-137).

Waiting times are a common metric to assess service-quality of mobile applications. For instance, the studies described in [11] investigated the change in user satisfaction as a function of the waiting time when performing various tasks on a mobile phone (loading a web-page, placing a phone call, sending an email and downloading content), and under various conditions of place of use and degree of relaxation.

Concerning mobile TV, the issue of channel switching delay has been tackled in the research literature mostly from a technical perspective so far. For instance Rezaei et al. investigated optimal channel switching delays for broadcast television over DVB-H, focusing on the decoder refresh delay and the buffering delay as main responsible factors for the overall channel changing time [12]. This study shows that minimal channel switching delays with DVB-H mobile TV can be expected between 0.9 and 1.6 second. A study by Hsu et al. shows that the burst broadcasting scheme used in DVB-H can be optimized to not only guarantee maximum channel switching delays of 500 milliseconds but also minimize the energy consumption of the mobile device [4].

Contrasting with the technology oriented discussions, user studies are lacking in the area, and most clues are provided by studies not specifically targeted at the user experience with channel switching delays on mobile devices. When designing their requirements for mobile TV, Knoche and McCarthy reported an early study of the streaming based MobiTV service in the USA showing that switching channels on handheld terminals occurred within 5 to 15 seconds [7]. The authors fear that the high contrast between switching delays on a mobile TV service compared to those on a fixed TV set may be a barrier for adoption. In 2006, a study of S-DMB mobile TV usage in South Korea reported that at the time it was common to experience delays of up to 10 seconds when switching channels on a mobile phone [2]. Despite this early work in the area, more recent and detailed studies of the acceptability of channel switching delay seem unavailable.

When it comes to IPTV systems, the ITU recommends channel switching delay to be below 2 seconds to guarantee a satisfactory Quality of Experience (QoE) [5]. Even though many studies in technology optimization have been conducted for desktop PC-based IPTV services, the results of these studies do however not apply to the mobile world due to constraints related to processing power. Nevertheless, these studies provide the closest reference to our concern available in the literature. Kooij et al. followed the ITU recommendation concerning the estimation of end-to-end performance in IP networks formulated in [6], and conducted a comprehensive user study validating a model that links channel switching delay and perceived quality expressed as a Mean Opinion Score (MOS) [8]. In both studies, the selected range of transition delays experienced by the test subjects is based on a logarithmic interpolation between predetermined minimum (0.1 seconds) and maximum (5.0 seconds) values of delay durations, selected according to observations about quality perception [10].

The experiment reported in [8] involved 21 test subjects who rated very short video clips (10 seconds, no audio, video resolution of 720×575) on a web-based interface displayed on a computer screen. When switching between the video clips, the test subjects experienced delays of 0, 0.1, 0.2, 0.5, 1, 2 and 5 seconds. The results from the experiment match the proposed model and indicate a threshold of 0.43 seconds as acceptable channel switching delay.

For what concerns the potential factors that can influence the acceptability of channel switching time, Godana et al. investigated the effect of displaying random advertisement pictures during channel switching delay ranging between 0 and 5 seconds on an IPTV system [3]. The results from the subjective experiment reported show that displaying advertisement improves the reported QoE for transition time longer than 0.65 seconds. However, showing advertisement only postpones the threshold at which users get annoyed. For short switching delays, the authors argue that a black screen generates better QoE, and for long delays, animated advertisement might improve the QoE compared to fixed advertisement.

In another experiment, De Watcher et al. proposed to display a low quality version of the channel to be displayed when switching channel on a fixed digital television [15]. This way, the authors argue that not only the perceived effect of changing channel is reduced for the user, but the method also optimizes the transition delay itself. In fact, a technical evaluation of the approach showed that it was possible to reduce the channel switching time from 1400 ms to 78 ms.

Summarizing this previous work, we can conclude the following:

- Few user studies have focused on the issue of acceptable channel switching delays for mobile TV
- Guidelines exist for dealing with this issue on fixed systems, but today's mobile TV technology cannot comply with them
- Improvements of mobile TV technology have been proposed but have not been implemented in market-ready products
- Various factors may influence the acceptability threshold of channel switching delays on mobile systems

3. USER STUDY DESIGN

To investigate the acceptability threshold of transition delay when switching between TV channels on a mobile device, video clips at a resolution of 640x480 pre-padded with a 'transition' were used and compiled into playlists. The reason for choosing this approach instead of e.g. a real DVB-H setup is that it allows for full control of the delay durations without depending on network conditions and other such environmental factors. The participants manually traversed the video clips using an iPod Touch. A custom-made web interface displayed on a laptop computer enabled participants to assess transition delays right after experiencing them. This aims at reducing any inaccuracy associated with recall-based assessment.

The acceptability experiment consisted in assessing the statement "The duration of the transition was acceptable" on a 6-point Likert scale ranging from 1-"Agree very strongly" to 6-"Disagree very strongly". A forced-choice response scale was deliberately chosen to reduce the central tendency bias.

A linear range of transition delays was selected based on observations of systems available today: fixed digital televisions offering short channel switching times (approximately 2 seconds) and DVB-H capable mobile phones with which longer delays are usually experienced (6-8 seconds).

The 40 participants who took part in the experiment were recruited among staff and students from the university. They were mostly males: 34 against 6 females. The participants were 30 years old on average, and highly IT literate.

In addition to identifying the threshold of perceived acceptability of the transition delays, the authors investigated the three following factors that may affect the rating of delays.

The transition type Two types of transition were used between the video clips. One type consists of displaying an animated icon on a blank screen while the other consists of a deteriorated version of the video clip (blurred video track together with unaltered audio track). The former represents the de facto standard loading symbol of today (as used by e.g. YouTube) while the latter simulates transition conditions that are good enough to deliver information in low quality only. This allows us to investigate whether quality or continuity is of primary concern to users when evaluating transition delays.

The test environment Two environments were used as a setup for the experiment: Firstly a quiet room without any visual or auditory disturbances allowing the participants to focus solely on the test. Secondly, a usability lab setup simulating an exterior environment while maintaining the benefit of controlled parameters. In the latter setup, participants seat in a dark tent, facing a video projection of a scenario relevant for the evaluation. In this case, the scenario selected was a 12 minutes bus ride filmed from a 1st person view aiming at exposing the participants to a social atmosphere during the test.

The audiovisual content Eighty-one video clips were recorded randomly from 43 Danish cable television channels during two sessions: one mid-morning and one mid-afternoon another day. Forty playlists (one per participant) were then created by randomly selecting 33 different clips. The playlists generated reflect a natural browsing session throughout 33 different channels. Although strictly speaking, each channel may appear twice in a given playlist as they were recorded twice, the content differs sufficiently to pass as a different channel.

4. RESULTS

4.1 Acceptability Threshold

The approach used to calculate the acceptability threshold consists in averaging the personal acceptability threshold of all

participants. The participants experienced delay durations three times each, in order to ensure data consistency. The median of the three responses is computed for each delay duration, which produces an array of 11 marks from 1-6 as depicted in Table 1. The personal acceptability threshold is then determined by the last acceptable value (1, 2 or 3 – with a white background) when reading the array from left to right. This approach favors lower delay durations to be considered as the threshold in cases where an acceptable mark is given to a delay that is longer than the one of the first unacceptable duration (as for instance the rating of the five seconds-long delay in participant 8's case illustrated in Table 1). We argue that a delay that has been rated as unacceptable should be given a higher priority, even though longer delays may have been rated as acceptable. The reason for this is that the experiment aims at identifying the threshold at which people start getting annoyed by the delay rather than the threshold at which they stop getting annoyed by it.

Table 1. Examples of medians and acceptability thresholds.

Participant ID	Delay duration (seconds)											Personal acceptability threshold
	0	1	2	3	4	5	6	7	8	9	10	
2	1	1	2	3	3	3	3	4	4	4	4	**6**
8	1	2	2	3	4	3	4	4	5	5	5	**3**

Once the personal threshold has been calculated for all participants, averaging them provides a general acceptability threshold. The first conclusion from this study is thus that the participants felt annoyed by delay durations longer than **5.7 seconds**.

4.2 Effect of Factors

We then investigated the effect of the transition type, test environment and audiovisual content of the video clips on the rating of individual transition delays. The hypotheses associated with these three factors are as follows.

H1: The ratings of transition delays vary significantly depending on the type of transition used between video clips.

H2: The ratings of transition delays vary significantly depending on the test environment in which the video clips are played.

H3: The ratings of transition delays vary significantly between video clips according to their audiovisual content.

To investigate hypotheses H1 and H2, one can perform analyses of variance (ANOVA) of the distribution of ratings according to the two factors of interest among clips that have been experienced under the same condition of delay duration and with the two values of each factor. In other words, the effect of the transition type is investigated for each clip experienced with deteriorated content and an animated icon at the same delay duration, and the effect of the test environment is investigated for each clip experienced in the lab and the tent at the same delay duration. However, the randomization of video clips used to create the playlists prevents from studying the effect of both factors simultaneously and their potential interaction. The effect of each factor is thus computed independently from the effect of the other factor.

Concerning the transition type, the one-way ANOVA performed shows that similar transition delays visualized as an animated icon were rated as more acceptable with a high level of significance (`p = 7e-4`). With regards to the test environment, the one-way ANOVA performed shows no significant level of variance between the simulated environment and the quiet room setups.

To investigate the impact of the content on the perceived acceptability of delay durations, an ANOVA has been performed on the ratings of all clips used in the participants' playlist. It shows low significance in the variance of the clips rating (`p = 0.019`). The following paragraphs extend this analysis in order to properly conclude on the effect of the video content on the acceptability of transition delays.

The clips have been categorized using a collapsed version of the LSCOM-Lite content classification scheme [9], focusing on the program categories "news" (political, financial and weather related) or "entertainment" (including sport and advertisement), the scene types "indoor" or "outdoor" and the display of a group of "people" or a single "person".

Since the audiovisual content only affects transitions during which the content is observable (in this case the deteriorated content version), the animated icon counterpart is used as a control for the rating. The difference in ratings for a given clip experienced at the same transition delay was then used as an indicator of the effect of the content on the rating.

However, no significant effect of any of the content categories used was found by the analysis of variance performed, which seems to indicate that the audiovisual content does not influence the rating of transition delays, and that the preliminary results presented above may be due to other factors.

Table 2 concludes on the three hypotheses concerning the effect of the transition type, test environment and audiovisual content on the rating of transition delays.

Table 2. Effect of three factors on the perceived acceptability of transition delays.

Hypothesis	Conclusion and comments
H1	Accepted with high significance (transition delays are rated as more acceptable when illustrated with an animated waiting icon than with deteriorated content).
H2	Rejected, only a tendency (transition delays are rated as more acceptable in the lab than in the tent).
H3	Rejected, transition delays are not rated differently according to the video clip audiovisual content.

5. DISCUSSION

In this section we discuss four issues that may further explain the outcome of the conducted experiment.

5.1 Consistency With Previous Research

The result of 5.7 seconds as acceptability threshold for transition delays seems inconsistent with the guidelines and the previous results presented in Section 2, in which much shorter delay durations are discussed. However it should be kept in mind that the guidelines in [10] apply to interactive computer systems in general and seems to overlook environmental factors such as ambient noise or distributed cognitive load inherent to mobile systems, while [5] focuses on IPTV systems (fixed).

5.2 Time Validity

The validity of these results in time is debatable, as one might argue that mobile TV technology will rapidly improve and most likely reduce current constraints and thus lower delays to a level

that complies with the guidelines for offering acceptable QoE. However, advertisers or researchers could exploit the fact that people are tolerant to some delays. For instance, displaying advertisement, as investigated in [3] seems to result in an unaltered QoE up to a certain duration. Another way of taking advantage of people's tolerance to delays would be to use this time to involve users in a "game with a purpose" (as defined in [14]), which could help e.g. tagging or rating audiovisual content.

5.3 Range Selection

In the work conducted in [5] and [8], the selected range of transition delays experienced by the test subjects is based on a logarithmic interpolation between predetermined values of delay durations. In the study presented in this paper, the choice of using a linear range of transition delays was motivated by observations of systems available today, ranging from low delays (2 seconds or less) in fixed TV systems to high delays (up to 6-8 seconds) in mobile TV systems.

Interestingly, in both cases the response of participants follows the distribution of the chosen delay range: a logarithmic range of delays generates a logarithmic response, while a linear range generates a linear response. This observation leads to questioning the choice of the range as a critical aspect of the test design, and calls for future work in the area. Indeed it seems rather difficult to argue for either of the scales with current experimental data.

5.4 Impacting Factors

The experiment shows that participants accept longer delays when exposed to an animated icon than to a deteriorated version of the audiovisual content, and therefore prioritize content quality over experience continuity. This result contrasts with the authors' prior assumption and the positive comments from test participants towards the latter visualization option. A potential explanation for this is the frustration that may occur when one can see only partially what happens on the screen, and hence the delay is perceived as more irritable. The presence of audio might add to the frustration for clips that rely on both audio and video for being understood.

The fact that the test environment does not significantly affect the ratings of transition delays is unexpected. However, this finding indicates that researchers can study delay transitions in a standard usability lab instead of simulating realistic test conditions.

The lack of significant impact of the audiovisual content on the acceptability threshold might be due to the short duration during which the content is important for the rating. Longer extracts might show variation in the perception of delays, as participants would get more involved into the topic of the clip.

6. CONCLUSION AND FUTURE WORK

In this paper we have described a user study assessing acceptable channel switching delays on a mobile device. The experiment reported in this paper shows that among young highly IT literate users delays of up to 5.7 seconds are considered acceptable when switching between two TV channels on a mobile device. Using an animated icon as a transition appeared significantly more acceptable than playing a deteriorated version of the content. However, neither the test environment nor audiovisual content had a significant impact on the perceived acceptability of transition delays.

Studying additional scenarios, for instance increasing the realism of the browsing session by involving content of interest for the participant, or jumping directly to a channel number could extend the delay study presented in this paper. Additionally, the choice of playing a low quality video when changing channel could be compared to displaying advertisements or playing games as an alternative during channel switching time. Finally, another content classification scheme could be used to investigate the impact of more specific audiovisual features, such as scene dynamics or color palette, on the rating of channel switching delays.

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Evaluating Ubiquitous Media Usability Challenges: Content Transfer and Channel Switching Delays

Alexandre Fleury, Jakob Schou Pedersen, and Lars Bo Larsen

Aalborg University, Department of Electronic Systems
DK-9220, Aalborg Ø, Denmark
{amf,jsp,lbl}@es.aau.dk

Abstract. As ubiquitous media is developing rapidly, new HCI challenges emerge. In this paper, we address usability issues related to the transfer of content between fixed and mobile devices, as well as channel switching delays on mobile devices. We first provide an extensive review of the field. We then evaluate four relatively novel approaches for initiating a transfer of video content from a mobile phone to a TV screen. Seen from a user's point of view, familiarity and comfort are found to be important decision factors when selecting a preference among the proposed methods. Furthermore, we identify a threshold level above which people appear to be annoyed when switching between TV channels on a mobile device, and investigate factors that may influence the perceived acceptability of such delay.

Keywords: Mobile media, content transfer, channel switching delay, user studies, simulated environment, WoZ.

1 Introduction

TV broadcasters are no longer only focusing on traditional TV sets when broadcasting content. For instance the British Broadcasting Corporation (BBC) [1] and Zweites Deutches Fernsehen (ZDF) [2] explicitly guarantee that their audience can get free access to services in ways and on devices that suit them - acknowledging that users want potential access to media at all times. In order to facilitate this, BBC as well as ZDF have launched in 2007 large media portals: the 'BBC iPlayer' [3] and the 'ZDF Mediathek' [2] both enable users to watch live TV as well as programs from the past week from e.g. internet-connected computers, set-top boxes, and mobile phones.

Broadcasters' intention of supporting multiple platforms and devices makes good sense as ubiquitous computing is becoming increasingly widespread and popular. A 2-month study of 11 mobile information workers in a large IT company in Finland showed that work-related tasks on a daily basis were heavily distributed between a wide selection of devices (e.g. desktop PCs, laptops and various handhelds). By doing so, the workers reported to benefit in terms of efficiency, multitasking, personal ergonomics, privacy and security. [4]

Similarly, Dearman and Pierce interviewed 27 workers and found that ubiquitous computing is not only present at work but also in private homes. In average,

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interviewees had one laptop/desktop PC at work/school, one laptop/desktop PC at home, one cellular device and at least one portable device (typically a digital camera or an iPod). The majority of them even had a laptop PC dedicated for bringing between work/school and home on a regular basis. The interviewees argued that several reasons exist for using multiple devices: form factor, device affordances, portability, and task completion time. In addition to switching between devices for different tasks, participants reported to increasingly engage in activities that span devices (e.g. using a laptop PC in combination with a desktop PC). [5]

In both studies, synchronizing information across devices was reported as a challenge for users. In order to cope with this, they used a combination of portable media, Emailing, shared directories and server-based services.

Combining the ubiquitous computing scenarios with the broadcasting of content to different platforms and devices enables 'ubiquitous media' as defined in [6]. In this paper, the typical ubiquitous media environment includes a TV, a laptop PC and a Smartphone on which users can either watch on-demand- or live-TV. As reported in [4] and [5] an unresolved usability issue exists however when trying to merge a media experience across devices: the synchronizing of information.

In addition, although a lot of focus has been placed on usability of mobile TV, an open issue exists still for what concerns acceptable response times for channel switching [7]. Providing low response times comparable to those known from standard TV is important, but the definition of 'low' remains unclear.

In this paper we therefore address those two unresolved usability issues related to the successful integration of TV and mobile devices: Video transfer across devices and TV channel switching delays on mobile phones.

1.1 Outline

In the next section, we provide an overview of previous research within the integration of fixed and mobile devices as well as TV channel switching delays. We then describe our study design, methodology and results for our two conducted experiments addressing these issues. We finally discuss the results and applied methodologies and provide a general conclusion opening for potential future work.

2 Previous Work

2.1 Integration of Media-Displaying Devices

Ubiquitous media and multiple-device environments have recently come to the close attention of scholars of various areas. In particular, the use of various devices in the home environment has been the focus of the ethnographic study reported in [8], which investigated media habits at home. After having identified the current and ideal home media use of 27 families, the authors designed an experimental mobile device acting as a second screen to control the TV channels as well as displaying photos on the TV screen. Sharing media content and especially broadcast multimedia files (including

long sequences) across devices with peers seems in fact to be one of the strongest drivers for mobile multimedia usage [9].

More concrete empirical studies have dealt with the integration of mobile devices with television sets. For instance it has been proposed to "put the EPG onto everyone's mobile phone" in order to personalize a shared TV in a typical family home [10]. According to the families interviewed during the ethnographic study, being able to access the EPG on their own mobile device and to personalize it allows family members not only to manipulate it without disturbing other TV viewers, but also to help resolving some conflicts with regard to the control of the TV.

A tendency emerging from the literature is that so far most studies have integrated mobile devices into the TV experience from a control perspective, the typical usage being the manipulation of content displayed on the TV screen from the mobile device, and the access to functionalities on the phone that complements the TV experience.

Most recently, the extensive work by Cesar and his colleagues on the concept of secondary screen illustrates the diversity of possibilities offered by multi-device media environments [11]. To this purpose, the authors have developed a taxonomy describing user behaviors in such environment. The taxonomy includes content control (what and how to consume TV content), content authoring (manipulating the TV content) and content sharing (communicating with others). Relevant to the present study, this taxonomy includes "presentation continuity", which allows users to bring their media content along on their mobile device when leaving the room in which resides the fixed TV set. According to Cesar et al., this feature has been mainly investigated through a technological perspective, disregarding user studies.

2.2 Channel Switching Delay

It is commonly accepted that channel switching delay is a critical usability issue with mobile television. The time and cognitive resources allocated to watching television on the move are limited, and users do not like to wait for neither the service to load on their mobile device nor for the channel to switch when requested [12].

This issue has been tackled in the research literature mostly from a technical perspective so far. Clues concerning user's opinion on the topic are provided by studies not specifically targeted at the user experience with channel switching delays on mobile devices. Additionally, there seems to be very little consistence between general recommendations available, technical solutions proposed and user studies performed on existing mobile TV systems, as summarized in Table 1.

Even though the last study mentioned in Table 1 focuses on IPTV and not mobile television, Kooij et al. have conducted the closest study to the one reported in this paper. The authors followed the ITU recommendation concerning the estimation of end-to-end performance in IP networks formulated in [19], and conducted a comprehensive user study validating a model that links channel zapping time and perceived quality expressed as a Mean Opinion Score (MOS). The "zapping experiment" involved 21 test subjects who rated video clips (10 seconds, no audio, video resolution of 720×575) on a web-based interface displayed on a computer screen. When switching between the clips, the test subjects experienced delays of 0, 0.1, 0.2, 0.5, 1, 2 and

5 seconds. The results from the experiment indicate a threshold of 0.43 seconds as acceptable channel switching delay. [18]

Table 1. Maximum acceptable channel switching delay according to various studies

Source	Study type	Max. delay
Nielsen, 1994 [13]	Recommendation	< 1 second (interactive systems)
ITU, 2007 [14]	Recommendation	< 2 seconds (mobile TV)
Rezaei et al., 2007 [15]	Technical	0.9 to 1.6 seconds (DVB-H)
Hsu and Hefeeda, 2009 [16]	Technical	500 ms (DVB-H burst broadcasting only)
Knoche and McCarthy, 2005 [17]	User	5 to 15 seconds (SMDB)
Cui et al., 2007 [12]	User	Up to 10 seconds (SDMB)
Koij et al., 2006 [18]	User	0.43 second (IPTV)

For what concerns the potential factors that can influence the acceptability of channel switching time, Godana et al. investigated the effect of displaying random advertisement pictures during channel switching delay ranging between 0 and 5 seconds on an IPTV system [20]. According to this subjective experiment, displaying advertisement improves the reported Quality of Experience (QoE) for transition time longer than 0.65 seconds. However, showing advertisement only postpones the threshold at which users get annoyed. For short zapping times, the authors argue that a black screen generates better QoE.

In another experiment, De Watcher et al. proposed to display a low quality version of the channel to be displayed when switching channel on a fixed digital television [21]. The authors argue that not only the perceived effect of changing channel is reduced for the user, but the method also optimizes the transition delay itself. In fact, a technical evaluation of the approach showed that it was possible to reduce the channel switching delay from 1400ms to 78ms.

With this previous work in mind, the next section presents our approach in addressing the first of the two unresolved usability issues related to the successful integration of TV and mobile devices, namely the transfer of video content from a mobile phone to a TV set.

3 Acceptability of Transfer Methods from a Mobile Phone to a TV

It seems that despite the number of technical solutions investigated to enable presentation continuity in ubiquitous computing environments, no user studies have been conducted so far to validate the approach against potential end users.

In comparison, our approach tackles the problem from the users' perspective only, regardless of technical requirements or limitations. In this purpose, our contribution is twofold: we verify the interest in transferring video content from a mobile phone to a TV, and seek to identify the preferred method from a usability perspective.

3.1 Transfer Methods

Four pre-selected sets of actions for handing over content were evaluated in terms of usability. The proposed methods were all inspired by common interaction paradigms.

Tossing. This action encompasses a method with which the user literally "tosses" the content from a mobile device to a fixed one, conceptually similar to interacting with the Nintendo Wii. Previous research has shown that 'tossing' as means of interaction is fun to use, although a bit difficult to grasp [22].

Proximity. Here the user has to physically approach a fixed device with the mobile device in order to transfer the content. Previous research has shown that users in general are willing to use 'touching' as means of interaction with devices when such devices are nearby, when security issues exist or when ambiguity is a concern [23].

Browsing. Here the user actively searches for equipment capable of taking over the presentation of content from a mobile device. Once located, the user selects a device and the handover is initiated. Previous research has shown that browsing may be seen as a very technical way of interacting with devices and that users therefore tend to avoid it when possible, unless the device in question is outside touching or pointing range [23].

Pointing. With this action (inspired by Point-and-Connect [24]), the user simply points at the device that is to take over the playback of the video from the mobile phone of the user. When pointed to a compatible device, its name appears on the mobile for the user to click on in order to initiate the transfer of content.

3.2 Setup

The content transfer experiment was conducted as a Wizard-of-Oz setup for which a web-based prototype (see Fig. 1) was developed, allowing video content to be 'transferred' between a mobile phone and a large flat screen TV connected to a computer, based on the actions of the test participant.

The user, only seeing the mobile phone and the flat screen TV, is lead to believe that (s)he actually controls on which device the video content is displayed. The user is also unaware that a wizard is observing his/her actions via live video recordings of the test scene and thereby determining on which device to show the video feed.

All participants are first introduced to a typical scenario in which they are to transfer content from their mobile phone to the TV screen. The facilitator instructs them to select, in turn, each of the four transfer methods on the home screen of the mobile phone application, and then to actually perform the transfer. The order in which the methods are evaluated is randomized for each user in order to minimize potential learning/biasing effects. Participants should comment on each of the four concepts immediately after experiencing it. Finally, after having tried the four concepts, they should indicate and justify their preferred method.

Fig. 1. Technical setup of the content transfer experiment

3.3 Results

Each participant was asked to specify a preference among the four concepts for initiating a transfer from the mobile phone to the TV. The results are shown in Fig. 2.

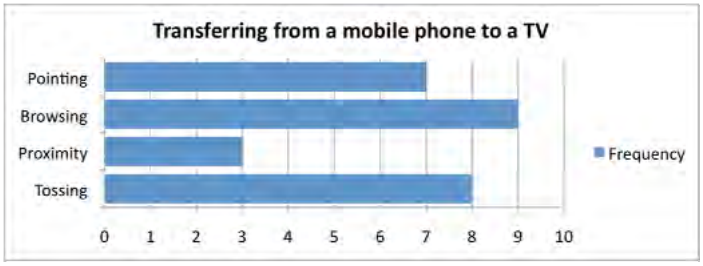

Fig. 2. Preferences when transferring content from a mobile phone to a TV

Based on these findings no significant conclusion can be drawn, although there appears to be a general dislike against the 'proximity' concept. This gives good reason to investigate closer the comments stated by the participants during the experiment. Based on these comments, the participants have been clustered into different groups indicating if they are predominantly positive or negative in their statements about each concept. From the comments collected, it can be inferred that tossing is a popular concept due to the fun of using it. Browsing and pointing are popular due to their resemblance to well-known interaction paradigms (respectively searching for devices under MS Windows and using a remote control). However proximity is not a popular concept, as it requires the user to move around physically which was perceived inconsistent with the context of watching TV.

4 Acceptability of Channel Switching Delay on a Mobile Device

To investigate the acceptability threshold of transition delay when switching between TV channels on a mobile device, video clips pre-padded with a 'transition' were used and compiled into playlists. This approach allows for full control of the delay durations without depending on network conditions and other such environmental factors. An iPod Touch was used to play the video clips and a custom-made web interface displayed on a laptop computer served to assess the transition delays.

The acceptability experiment consisted in assessing the statement "The duration of the transition was acceptable" on a 6-point Likert scale ranging from "Agree very strongly" to "Disagree very strongly". We deliberately chose a forced-choice response scale to reduce the central tendency bias. A range of transition delays (0-10 seconds) was selected based on observations of systems available today: fixed digital televisions offering short channel switching times (approximately 2 seconds) and DVB-H capable mobile phones with which longer delays are usually experienced (approximately 6-8 seconds).

In addition to identifying the threshold of perceived acceptability of the transition delays, we investigated three factors that may influence the perceived acceptability.

4.1 Possible Impacting Factors

Transition Type. Two types of transition were used between the video clips. One type consists in playing the clip of which the video is blurred while the other consists in displaying an animated icon on a blank screen. The former simulates transition conditions that allow delivering content in low quality only, while the latter simply informs the user that something is happening on the device.

Test Environment. Two environments were used as a setup for the experiment: a quiet room where nothing happened besides the test and a usability lab setup that simulated an exterior environment without actually going out in the field. In this case, the scenario for the simulation was a bus trip: the participants were sitting in a dark area, facing a video projection of a 12 minutes bus ride filmed from a 1st person view.

Video Content. Eighty-six video clips were recorded randomly from 43 Danish cable television channels during two sessions on different days. Forty playlists were then created by randomly selecting 33 different clips from the 86 available. The playlists reflect a natural browsing session throughout 33 different channels.

4.2 Results

Acceptability Threshold. Each participant experienced delay durations three times each in order to ensure data consistency. The median of the three responses is computed for each delay duration, producing an array of ratings per participant for all delay durations. Individual thresholds are then determined by the last acceptable rating when reading the array from short to long durations. This approach favors lower delay durations if an acceptable mark is given to a delay longer than the one of the

first unacceptable duration. We argue that a delay rated as unacceptable should be given a higher priority, because the experiment aims at identifying the threshold at which people start getting annoyed by the delay rather than the threshold at which they stop getting annoyed by such delay. Once the personal threshold has been calculated for all participants, averaging them provides a general acceptability threshold. The first conclusion from this study is thus that the participants felt annoyed by delay durations longer than 5.7 seconds.

Effect of Factors. We then investigated the effect of the transition type, test environment and audiovisual content of the video clips on the rating of individual transition delays, according to the following hypotheses.

H1: The ratings of transition delays vary significantly depending on the type of transition used between video clips.
H2: The ratings of transition delays vary significantly depending on the test environment in which the video clips are played.
H3: The ratings of transition delays vary significantly between video clips according to their audiovisual content.

For what concerns the transition type, the one-way analysis of variance (ANOVA) performed shows that similar transition delays visualized as an animated icon were rated as more acceptable with a high level of significance ($p = 7e\text{-}4$). With regards to the test environment, the one-way ANOVA performed shows no significant level of variance between the simulated environment and the quiet room setups.

To investigate the impact of the content on the perceived acceptability of delay durations, the clips have been categorized using a collapsed version of the LSCOM-Lite content classification scheme [25] focusing on the program categories “news” or “entertainment”, the scene types “indoor” or “outdoor” and the display of a group of “people” or a single “person”. No significant effect of any of these categories was found by the ANOVA performed, which seems to indicate that the type of content does not influence the perception of transition delays.

Table 2 concludes on the three hypotheses concerning the effect of the transition type, test environment and content type on the rating of transition delays.

Table 2. Effect of three factors on the perceived acceptability of transition delays

Hypothesis	Conclusion and comments
H1	Accepted with high significance (transition delays are rated as more acceptable when illustrated with an animated waiting icon than with deteriorated content).
H2	Rejected, only a tendency: transition delays are rated as more acceptable in the lab than in the tent.
H3	Rejected, transition delays are not rated differently according to the video clip audiovisual content.

5 Conclusions and Potential Future Work

In this paper we have investigated usability issues related to ubiquitous media environments. Especially, we have focused on transferring video content from a mobile phone to a TV and on acceptable channel switching delays on a mobile device.

Among the four concepts for initiating a transfer of content from a mobile phone to a TV no significant preference has been found. The lack of conclusive result in terms of preferred method and the somewhat contradictory comments can be interpreted in two ways when it comes to inform potential designers of a market-ready application. Firstly, the pros and cons of each method may equal out among participants, who individually may value different features. In that case, the application should offer end users the possibility to choose among various transfer methods. A second solution would be to encompass all positive features found in the methods evaluated in this study: remoteness (transfer content from afar), directedness (target one specific device), memory (remember devices) and enjoyability (fun to use).

The second experiment reported in this paper shows that delays of up to 5.7 seconds are considered acceptable when switching between two TV channels on a mobile device. The type of content played did not significantly impact this result. For such delay duration, displaying a blank screen with an animated icon was perceived significantly more acceptable than displaying a blurred version of the video feed. The fact that the environment did not impact the results indicates that researchers may conduct such study in a standard usability laboratory without setting up a test environment with a high level of realism.

A real implementation of the content transfer methods would possibly uncover additional usability aspects caused by technical constraints. Additionally, examining participants' reactions when experiencing the four transfer methods could provide further insights on the preference they reported verbally. A behavioral classification scheme could be established in order to do so.

Investigating other scenarios, such as jumping directly to a known channel or skipping over several channels at once, could extend the delay study.

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Drawing as a User Experience Research Tool

Alexandre Fleury
Aalborg University
Niels Jernes vej 12
9000 Aalborg, Denmark
amf@es.aau.dk

ABSTRACT

This paper discusses the use of participant-generated drawings as a user experience research method. In spite of the lack of background literature on how drawings can generate useful insights on HCI issues, drawings have been successfully used in other research fields. After briefly introducing such previous work, two case studies are presented, in which drawings helped investigate the relationship between media technology users and two specific devices, namely television and mobile phones. The experiment generated useful data and opened for further consideration of the method as an appropriate HCI research tool.

Categories and Subject Descriptors

H.5.2 [**Information Interfaces and Presentation (e.g. HCI)**]: User Interfaces – *evaluation/methodology*.

General Terms

Measurement, Experimentation, Human Factors.

Keywords

Drawing, user experience, memories, television, mobile phone.

1. INTRODUCTION

Exploring detailed aspects of people's life can be done in many ways: Standard ethnographic methods include interviews (in-depth, repeated), activity logging (automatic or via diaries) or remote prompting. These methods help researchers immerse into people's life more or less deeply and over various time periods, from a specific point in time to several weeks, months or even years. However efficient these methods are, they suffer from being time consuming in planning, conducting and analyzing. Sometimes one might need a snapshot of a specific part of people's life from a sample of participant bigger than what can be afforded using the abovementioned methods. Decreasing the resources necessary to measure personal user experiences has been on the agenda of HCI researchers, and thus rapid UX evaluation strategies have been developed and applied. Beebe introduced and defined "Rapid Assessment Process" [3], and Miller further proposed to focus on three key aspects of evaluation design [6]: Focus and key informants (to limit the amount of data collected), Interactive observations (to improve the quality of the data collected), and Collaborative data analysis (to help analyzing the data collected).

This paper examines how drawings can tackle the methodological challenge of providing deep insight on test participants' personal matters in an easy way, in a timely fashion, and using a relatively large sample size. The type of personal stories collected and the level of intimacy user experience researchers can access through drawings will be exemplified through the application of the method to a specific research agenda, namely investigating the relationship between users of televisions and mobile phones and the devices.

The study related in this paper partly took place during a visit to a foreign institution as part of the author's doctoral study. The socio-historical approach to media studies taught at the visited institution encouraged the author to investigate technology-free user study tools. Moreover the cultural and linguistic gap experienced during the stay provided an excellent opportunity to try non-verbal user experience investigation methods.

2. DRAWING AS A RESEARCH METHOD

Drawings and sketches have been part of humans' communication tools palette since their early evolutionary stage. Whether it is for visualizing specific ideas, expressing artistic inspiration, supporting learning process, or ensuring durable memory, drawings are used almost everywhere. In fact when learning how to express themselves, humans rely on drawings very early, prior to writing. In their first years of life, children learn to use drawings as a communication mediator. At the same time, the child gradually includes writing in the drawings, enhancing clarity in the ideas expressed [1]. The important role drawings play in human development explains the vast academic literature available related to children's drawings and their interpretation.

It has been argued that simple drawings can help convey complex ideas, especially in the business world [8]. For instance Dan Roam demonstrates that drawings help clarifying ideas, expressing them rapidly without the need for complex technology, and sharing them openly encouraging discussions. It is further argued that "*the value of visual information lies […] during the action of drawing*", that is during the creation process of the image rather than in the image itself [7]. Mills considers drawing as a visual conversation, for which the performance itself is crucial to make sense of the message conveyed.

In design, drawings are widely used in order to illustrate and explore scenarios and ideas through storytelling, and storyboards are considered an efficient and powerful tool for illustrating a succession of events [9]. Exploring people's life, opinions and thoughts through drawing are however less popular.

Recently, ethnographers have used drawings to discuss medical conditions with patients. While using drawings for exploring how people understand illness, Guillemin demonstrated that drawings can indeed generate a broad and in-depth perspective on the study at hand. The author agrees with Mills in saying that studying the drawing produced alone is not enough, but should be complemented by the analysis of the knowledge built by the drawer while creating the drawing [4]. Additionally, Guillemin notes that a drawing is a snapshot of how the drawer understands a subject at the specific time of the drawing. She reckons the limitations of this visual expression tool and argues that drawings should be used as a complement of additional research methods.

Guillemin's findings are corroborated by Kearney and Hyle who identified the following benefits and drawbacks of using drawings as a research method for investigating the emotional effects of change in an educational institution [5].

1. Drawings reveal emotional aspects that would not be covered in word based communication
2. Participant focus on the key aspect of their story
3. Drawings needs to be complemented by participant explanation
4. Response to the drawing task varies according to personal and situational characteristic that may be hard to control
5. The lack of boundaries associated with drawing alleviates participants freedom of expression
6. Likewise, researcher-imposed structure determines interpretation of drawings
7. Drawings is suitable for data triangulation when used in complement to other research tools

Furthermore, considering drawings as a support for focus groups involving children, Yen presented evidence that drawings had the following positive effects on the study outcome [11].

8. It helped create a relaxed and comfortable atmosphere, and released the pressure to answer immediately
9. It enhanced the communication between the researcher and the children by providing further insight on the children's perspective on the topic discussed, as well as offering children the possibility to express more personal experiences
10. It allowed better identification of groupthink and gave each idea expressed an equal chance for consideration

It should also be reminded that drawings can be culturally reflective. In a study comparing children drawings in Japan and the United States, La Voy et al (2001) discovered that when drawing people, Japanese children tend to include more details and represent humans larger but with fewer smiles than their American counterpart. These differences are explained by cultural clues of how children are raised in both societies. [10]

A limitation to the method, which is common to all qualitative methods, is a matter of validity, bound to interpretation. When someone (the drawer) communicates an idea through drawing to somebody else (the viewer), the idea goes through various levels of interpretation, which may alter the original meaning thought of by the drawer. First, mental images are hard to draw due to their high level of abstraction, their tendency to get easily disturbed, and their dimensionless nature [2]. Second, the drawer verbalization and viewer interpretation are prone to inaccuracies potentially leading to confusion. However this critique applies to any visual- and verbal-based exchanges between an author and an audience. Rather than considering this an issue, Guillemin suggests considering the drawings as one of the many ways to perceive the study subject.

3. CASE STUDIES

This section presents two specific applications of drawing as a mean of understanding the relationship between media technology users and two media devices: television and mobile phone. The first case served as a pilot study in order to test and improve the method. Nevertheless, it also generated valuable data which can be analyzed. The second iteration builds from the pilot study and was conducted in a different cultural environment.

3.1 Pilot Study: Project Seminar in Japan

3.1.1 Setup and participants

The pilot study took place as a social event during a three-day project seminar. All participants knew each other, for the project had been running for several years and members met at multiple occasions prior to the seminar. After the second day's dinner, everyone gathered in the meeting room where further discussions about the project were to take place after the drawing experiment. Participants were handed a set of paper sheets. On the first sheet, a description of the author's project and the purpose of the study reminded the participants about the experiment. The four remaining sheets contained a few lines of instructions and a large empty square on the rest of the page for drawing. Pens of various types and colors were available to all participants, who could use any combination of them. Participants were sitting on the floor either in small groups or individually. Interaction between participants during the experiment was possible but not mandatory. A total of 30 minutes was allocated to the entire test, including introductory speech. The sets of paper sheets were collected after each participant completed his/her drawings, in order to limit potential alterations.

Twenty-one participants took part in the pilot study. At thirty-six years old in average, they were mainly males (17 against 4 females). Their occupation was closely related to the academic world, and included nine researchers, five students, four professors, two assistant professors and one graphic designer.

3.1.2 Tasks

The study investigated participants' relationship with TV and mobile phone separately: The two first sheets focused on television and the two last on mobile phone. On the first sheet participants were asked to draw the layout of their house, indicating the media devices regularly in use. Additionally, participants were instructed to illustrate media devices used simultaneously. For the second drawing, participants were asked to illustrate an impressive memory related to television. It could be a memory about anything that marked them somehow deeply. The drawings concerning the mobile phone followed the same approach: First participants had to picture themselves, depicting the mobile devices they carry around with them. Then they should recall and illustrate an impressive memory associated with their personal mobile phone.

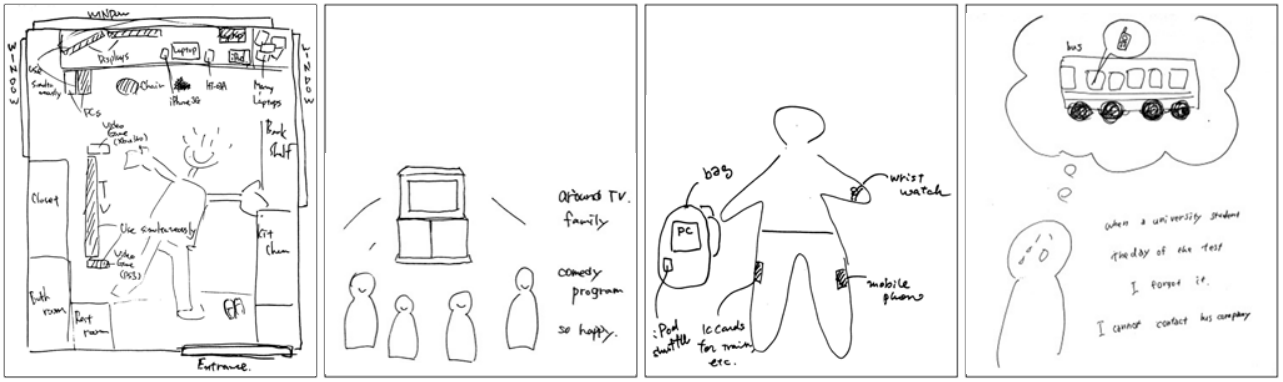
3.1.3 Results

Analyzing the data collected solely based on the drawings can be a difficult exercise and has been argued to be insufficient [4]. Nevertheless, as a first step into the analysis it leaves the opportunity to interpret participant answers and identify trends and categories. Later this can be used for selecting a few participants for further examining representative contributions.

Focusing on home media usage, the analysis should filter out the excess of information that appears in most drawings. Sketching the layout of the home is only the support task for studying where and how media devices are used in the home. This comment is actually valid for all drawings regardless of the topic at hand. As illustrated in Figure 1-(a), Japanese home drawings are usually complemented by text clarifying a device, piece of furniture or specific use situation.

When asked to depict a memory related to television, the majority of Japanese participants (58%) portrayed memories related to the TV content, and little about the device itself or the social interaction around it (21% each). Half of the memories (50%) involved the participant alone, and 29% involve family members (as illustrated in Figure 1-(b)).

Self-depicting oneself leads to reflecting on one's behavior, which some Japanese participants expressed through there drawings. Additionally, four participants specifically represented several situations in which they carry mobile devices. In general, participants depicted themselves carrying 2.5 mobile devices



(a) (b) (c) (d)

Figure 1. Drawings collected during the Japanese project seminar illustrating a home and media devices in use (a), an impressive memory involving TV (b), a self-depiction including mobile devices (c) and an impressive memory involving mobile phone (d).

(such as mobile phones, computers, or music players). A few considered more exotic devices (e.g. watch, transportation cards). Concerning mobile phones, they were mostly located in a pants pocket (48%), often in a bag (26%) and sometimes in a jacket pocket (19%). Figure 1-(c) is an example of typical self-depiction.

Finally, memories about mobile phones mostly related to experiences where the device had been broken, lost, forgotten or otherwise misused (48%, as depicted in Figure 1-(d)), as well as specific use situations (43%). Those memories were mostly associated with negative feelings (52%), rather than positive (24%) or neutral (14%) ones. Even more than with memories involving TV, mobile phone related memories concerned the participant alone (62%).

3.2 Study 2: Graduate Course in Denmark

The second experiment repeated the pilot study in a different cultural context, and included a few minor modifications in the setup. The tasks remained strictly identical in both studies. The participants also differed in the second study as all were graduate students attending a User Experience Design course.

3.2.1 Setup and participants

This study took place during a two-hour lecture introducing students to qualitative methods for user experience research. The exercise was conducted after a short break at the beginning of the second hour of the lecture. The lecturer gave a brief and general introduction to the method before starting the exercise, which lasted about 20 minutes. The task sheets differed from the pilot study by the size allocated to each drawing. In order to avoid potential blank page syndrome, two drawings were expected per page, instead of one per page during the pilot. Participants were sitting at their desk as during the lecture and could interact between each other. Pens were distributed to participants who didn't have one.

Thirty-seven graduate students took part in the second study. They were again mostly males (26 against 11 females) and 24 years old in average.

3.2.2 Results

Drawings from the Danish students could be categorized in a similar way then their Japanese counterpart.

The home drawings can be classified in two categories according to the amount of details included. The range of complexity between drawings varied considerably from minimalistic (illustrated in Figure 2-(a)) to very detailed, a short majority belonging to the former category.

When it came to remembering a remarkable event related to TV, Danish students mentioned the device itself in majority (46%), mostly illustrating scenes of use or acquisition (illustrated in Figure 2-(b)). Memories related to the TV content (38%) as well as the surrounding social environment (29%) were also mentioned. The people involved in most of these memories as well as the associated feelings were unclear and were matter of interpretation.

Danish students represented themselves carrying 1.8 mobile devices in average, mostly focusing on the cell phone, sometimes complemented by a laptop or music player. Most participants (38%) represented themselves using their mobile phone, hence carrying it in their hand (as illustrated in Figure 2-(c)). The second most popular location for carrying mobile phones was the pants pocket (35%). A surprisingly representative number of drawings (16%) pictured the user and devices separately.

Finally, memories related to mobile phones referred equally to situations in which the device was broken, lost, or misused, than to specific use situations (37% each). Those memories involved mostly the participant alone (58%). As with the TV-related memories, the feelings associated with mobile phone related memories were very hard to identify without making assumptions based on the content depicted.

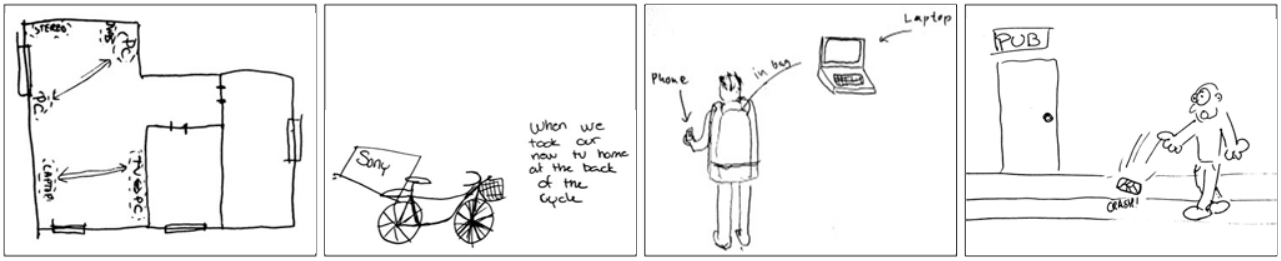
4. DISCUSSION

The following topics emerged in the high-level evaluation of the drawings collected through the two studies.

4.1 Personal Matters

It seems that drawing makes it easy to express personal matters. In both Japan and Denmark, intimate stories were depicted. It is argued that these stories would take longer to collect through verbal interviews, as the act of drawing provides both a personal sphere to reflect in (centered around the paper sheet) as well as time to think and organize one's thoughts.

It is further argued that drawing provides an opportunity for reflecting on one's behavior, which opens for further discussions with the drawer. For instance both Japanese and Danish participants realized that they were sometimes using two phones at the same time and that could be considered strange.



(a) (b) (c) (d)

Figure 2. Drawings collected during the Danish graduate course illustrating a home and media devices in use (a), an impressive memory involving TV (b), a self-depiction including mobile devices (c) and an impressive memory involving mobile phone (d).

4.2 Ubiquitous Mobile Phones

Environmental factors should be considered when asking people to remember a remarkable event related to a specific device. Some participants in both Japan and Denmark expressed their difficulty to think about such a memory related to mobile phones. In fact they considered the device to be so present in their everyday life that finding an extraordinary event linked to it was hard.

4.3 Japan vs. Denmark

In general Danish drawings were more ambiguous and harder to interpret on their own than the Japanese ones. For instance it was easy to determine whether a Japanese memory was associated with positive, negative or neutral feelings. On the contrary drawings collected in Denmark were ambiguous and could only be guessed, calling for further discussion with the authors.

In both countries most memories related to mobile phones referred to the use or misuse of the device by the participant alone. However when remembering an event related to TV, Japanese participants referred mostly to the TV content, while Danes focused on the device more frequently. Japanese also visibly experienced these events either alone or with family members, while Danes were more ambiguous on the matter.

4.4 Acquaintance among Participants

Even though test users should work on their own to produce the drawings, the presence of colleagues, friends or strangers around might influence productivity and the level of attention to details. However, the drawings collected during both experiments seem to indicate no influence of the level of acquaintance among subjects on the output. It could even be argued that both familiar and unfamiliar social surroundings may positively influence how people perform during such activity. In a familiar social setting, one might want to produce something to impress or amuse friends, and when surrounded by strangers, one might want to appear assiduous. Nevertheless, consistency bias may occur in case of participants exchanging heavily during the study.

5. CONCLUSION

To the extent of the knowledge acquired while conducting the study and during the evaluation process, drawing seems to provide qualitative insights on the user experience with technology. The following statements have been verified and summarize the findings of the experiment so far:

1. Drawing helps create a relaxed and comfortable atmosphere in which test participants are willing to express personal matters
2. The absence of boundaries in drawings further encourages participants to reveal personal aspects of their lives
3. Responses are influenced by the experimental setup
4. Drawings should be used in triangulation with other research methods

These findings however need to be further investigated, combined with additional user experience evaluations as suggested in the literature and compared to other inquiry methods in order to assess the performance of drawings as a useful HCI research tool.

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Experience Sampling as a Study Method of Mobile Media Consumption

Jakob Schou Pedersen
Dept. of Electronic Systems
Aalborg University
jsp@es.aau.dk

Lars Bo Larsen
Dept. of Electronic Systems
Aalborg University
lbl@es.aau.dk

Alexandre Fleury
Dept. of Electronic Systems
Aalborg University
amf@es.aau.dk

ABSTRACT

In this paper, we address experience sampling as a study method of mobile media consumption for the Norwegian MiniTV mobile TV service. The main findings regarding the responses we obtained from a four week Experience Sampling campaign, where we received a total of 200 responses from 17 users, who were prompted 2 times per day, giving an overall response rate of 21%.

The main findings about the usage and social and locational contexts show that the miniTV is mainly used during transportation (public or private).

The campaign suffered from some technical problems, leading to a lower than expected response rate and a main conclusion is to stress the importance of the communication and motivation of respondents in experience sampling scenarios before and throughout the sampling period.

Categories and Subject Descriptors

H.5.2 [**User Interfaces**] Ergonomics, Evaluation/methodology, Theory and methods, User-centered design.

General Terms

Human Factors, Experimentation, Measurement.

Keywords

Experience sampling, mobile media, smartphones, user studies.

1. INTRODUCTION

This paper address the suitability of experience sampling (ES), defined in 1983 by Larson & Csikszentmihalyi [1] as a method for a mobile television study. The purpose of ES is to record feelings, actions and momentary thoughts of people in their normal everyday life (striving towards ecological validity) – in this case pertaining the usage of mobile television.

As Cherubini and Oliver put it, '*It [Experience sampling] consists of randomly or semi-randomly sampling the user experience, usually by sending a message to the participant and asking him/her to answer a short questionnaire on a mobile device right at the moment when a relevant event is produced*', [5]. In addition to answers constituted by simple selections or written input to questions, voice recordings, pictures and video clips could also be valid input from respondents during ES, [6].

Contrary to recall-based self-report procedures such as diary writing and Gaver's cultural probes [4], ES does not require respondents to retrieve or reconstruct data from their memory as it allows respondents to report content and awareness in situations in which that awareness takes place and minimizes thus cognitive bias. Naturally, the validity of ES depends however on the assumption that respondents have access to information of relevance and actually want to report it, [1].

Following this section, some of the important parameters for ES is discussed in section 2. Section 3 presents our study and section 4 reviews some of the findings, which are discussed in sections 5 and 6.

2. EXPERIENCE SAMPLING

ES has been employed in a large number of studies, see [1],[2],[3],[5],[6],[7],[8],[10],[11]. In particular, the advent of smart phones as a convenient technical platform has given rise to a number of frameworks for ES, e.g. [9],[12]. This section discusses some of the most important parameters for an ES study; the timing and frequency of the prompts and the motivation of the participants.

2.1 Timing

Sampling (or prompting) can occur either at random (signal contingent), scheduled/at regular intervals (interval contingent) or in response to events of interest (event contingent) with adjustable levels of prompting questions that can be presented in a fixed or random order, [1].

In [7] it is cautioned that scheduled and event-based sampling might introduce cognitive bias (for the latter, especially if the events are triggered by the participant). A refined ES method (rESM) for use with cell phones has therefore been proposed that automates the collection of data via information that can be captured from the cell phone (e.g. automatic picture taking) and that furthermore is triggered by objective user-generated events (e.g. the user making a phone call), [5]. Similarly, the MyExperience open source project by Froehlich and colleagues [8] allows the participants to respond with photos, audio recordings or rating scales. The platform is very flexible and allows the experimenter to define new prompting schemes, such as clickable bitmaps, etc. One drawback is that it only runs on Windows Mobile Phones [9].

As the use of mobile TV happens independently of cell phone usage, MyExperience or rESM do not seem suitable for this study. Random sampling seems therefore most appropriate – of course within a suitable time window during the day (e.g. 08.00-20.00 to cover the day time as well as situations of use during morning and evening activities) in order not to disturb respondents unnecessarily. The duration of the entire survey was planned to be up to two months.

2.2 Frequency

The amount of prompts (per day and in total) sent to participants when prompting in situ is always to be carefully considered. Again, this is a tradeoff between validity, outcome and

motivation. By prompting too aggressively (in order to obtain a large number of samples) there is an increased risk that respondents get annoyed or suffer from general fatigue and give up – with the consequence of less or biased data collected.

In [10] 11 participants were prompted approximately 6 times a day within a 10-hour time window over a period of 10 working days. With this setup an average response rate of approximately 68% was obtained.

In [7] users' information needs were investigated using ES. Here, 31 participants were prompted 10 times a day within a 12-hour time window over a period of 7 days. With this setup an average response rate of 80% was obtained. In this study, it was furthermore investigated *why* respondents did not reply to all prompts. According to the respondents, the primary reasons for this were inconvenient situations of being prompted and not noticing the alert (vibration alert from a Palm m500 pocket PC).

The daily prompting frequency for the substantially longer period (months instead of days) intended in this work needs to be somewhat lower than in the studies referred to above: Assuming that an average response rate of approximately 75% is considered acceptable, and if the proportion is related (among other factors) to the total amount of samples this can be calculated to not exceeding 65 prompts for the duration of the study. Assuming a two month period, each respondent is thus to be prompted twice a day.

2.3 Motivation

Maintaining a constant motivation for the respondents to participate in a survey is of crucial importance to the overall outcome of this. The task of motivating respondents can be argued to be two-fold; first, participants need to be motivated to actually take part in the survey. Secondly, they need to be motivated to *keep* participating.

Financial compensation is typically used when trying to motivate people to take part in ES activities. As an example, participants in the survey described in [7] were offered an incentive of $50 for participating (and returning equipment) plus $1 for every completed questionnaire. Determining an appropriate amount of compensation is critical: A too low reward may not attract enough participants. On the other hand, a too high reward may attract participants who are not intrinsically motivated to participate, [11]. As argued in [11] a better approach may be to assure that respondents understand the importance of the study.

For this study a combined approach is taken: In addition to participating in a lottery with tickets to popular TV shows, respondents are explained that by participating they may have the opportunity to shape the future of mobile television. Respondents who complete all surveys (ie. an initial recruitement survey, the ES prompts and a post-test survey) also take part in a final draw for a mobile TV receiver.

The task of maintaining motivation throughout the entire survey period can be approached in a number of ways. In addition to offering incentives, another way is to limit the burden that respondents feel by participating in the survey. Questionnaires have therefore been designed to take no longer than two minutes to complete, as recommended in [7].

3. RECRUITEMENT AND PROMPTING SCHEME

This section describes the recruitement of participants and the employed ES prompting scheme.

The approach taken in this study consisted of three phases:

1. Recruitment and pre-screening.
2. Longitudinal in situ study of user behavior.
3. Post-interviewing.

For the first phase, a piggy-bagging strategy was applied through which participants from a prior survey campaign among users of the Norwegian miniTV mobile television broadcast network were invited to take part in our study as well. In addition to this, miniTV viewers were invited through advertising web-links displayed in the broadcast stream. A third scheme was via postings in the miniTV Facebook group. For all strategies, participants were informed that the study would be ongoing for a longer period of time and consist of several prompts a day on their cell phones. An important requirement was that the participants must own a smartphone (defined as a mobile phone with a web browser and 3G access), as the participants were to use their own phones and miniTV terminals.

This resulted in a total of 17 participants who agreed to carry out the whole longitudinal study. Out of these, 13 actually completed it.

All participants were pre-screened to get an overview of their background, demographic properties and media habits before actually being subjected to this study.

3.1 Prompting and Data Collection Platform

For the second phase a server-based prompting framework utilising SMS and mobile web communication was applied. As illustrated in Figure 1 the basic concept is that a server sends out text messages to the participants containing a link to a brief online corresponding questionnaire. The participants click on this link and fill out the survey using the built-in web browser of their cell phone. After having done so, the participants can submit their answer to the prompting system which stores this in a database. In the present study, a platform developed by UNWIRE [12] was used. Among other functions, the platform ensures optimal formatting of the forms, depending on the type of the mobile phone used, and records the users' ID through URL encoded ID-numbers. Thus, it is possible to keep track of individual participants' responses without depending on technologies such as cookies.

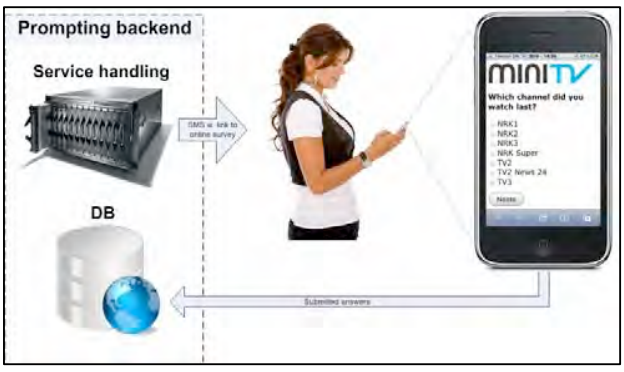

Figure 1 The prompting framework used in the study.

The platform includes a web-based administrator interface, allowing experimenters to design the prompts, define when and to who to send the SMSs, track and record the responses and compile various forms of brief summaries presented graphically. The full data sets can be downloaded and imported into e.g. Excel or a statistical package for analysis.

4. RESULTS

The focus is on the ES itself as a method, rather than the concrete information about mobile media use we gained during the ES. The main findings regarding the responses we obtained from a four week ES campaign, where we received a total of 200 responses from 17 users, who were prompted on average 2 times per day giving an overall response rate of 21%.

4.1 Daily Response Distribution

Figure 2 below shows the distribution percentage of the prompts answered by the respondents during the daytime.

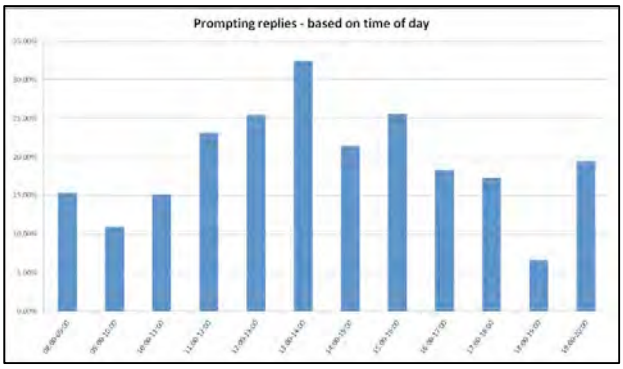

Figure 2. Time Distribution of prompts.

The prompts were sent randomly between 8-20 hours, and there is clearly a preference for the period from noon into the afternoon for responding.

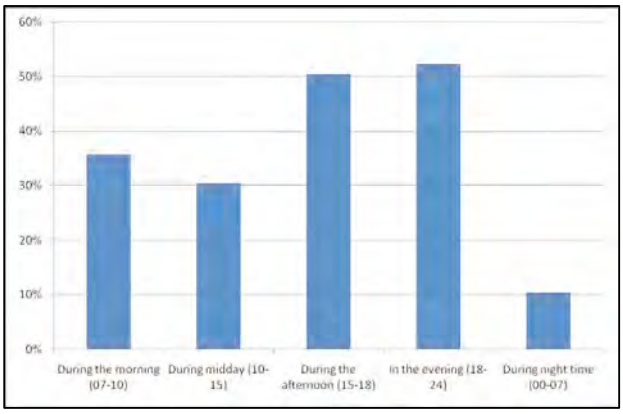

Figure 3. User's reported preferences.

This fits well with the reported preferences in the pre-screening questionnaire, as shown in Figure 3, where 50% of the respondents finds MiniTV most useful in the afternoon and evening.

4.2 Response Distribution over the ES period

Figure 4 shows the response distribution during the four week ES period. There is a very clear drop in responses after the first five days. On day six, there is a clear peak and after that, the response rate stabilizes at a much lower rate. This is due to a software error in the ES platform, which resulted in an excessive number of prompts being sent to the respondents. As a consequence no prompts were sent on day seven, which causes the gap in the graph.

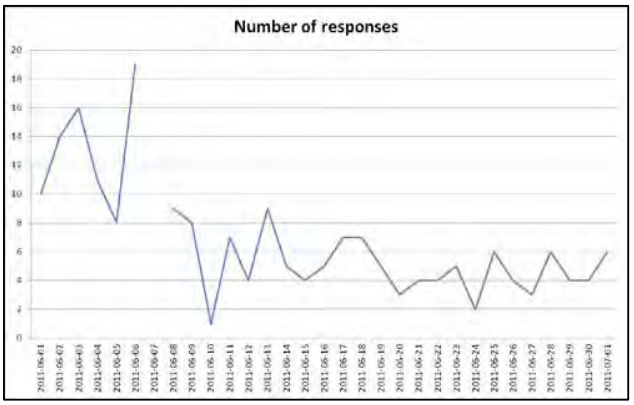

Figure 4. Response rates during the four week period.

4.3 Location and Social Context

A number of the prompts dealt with the location and social context in which the MiniTV was used. These were repeated throughout the ES period. The responses are showed that MiniTV was mainly used during transportation (71%), on the job (7%) or in other situations (21%), such as outdoors.

Regarding the situational context, 47% reported they last used MiniTV to seek "privacy in a public setting", 29% last watched MiniTV with friends or family during public transportation and 12% watched it alone during transportation.

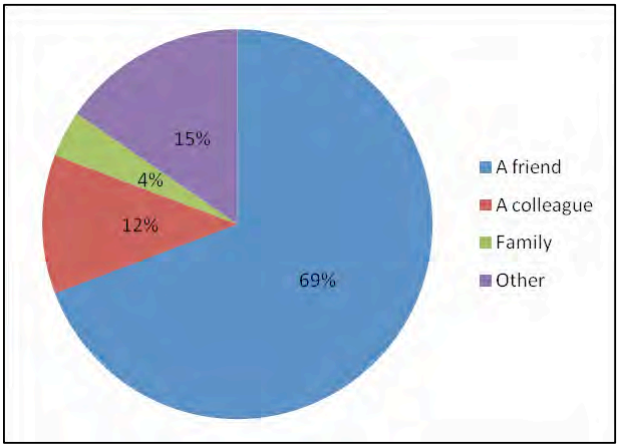

Figure 5. Social context.

Figure 5 shows with whom the respondent last watched miniTV. There is a very clear preference for watching with friends or colleagues (81%) rather than family.

In the pre-test survey 58% of the respondents reported that they find "during transportation" a most useful situation. Other significant responses are "at the job" (25%), "as extra TV screen at home" (35%) and "waiting for someone" (46%) and "when I absolutely must watch a program" (56%).

Apart from "transportation", this is quite different from the ES responses. However, the ES survey did not include evenings after 20 hours, so this probably explains why the "extra TV screen at home" is not present there.

5. DISCUSSION AND CONCLUSIONS

Looking at the results it is evident that both the number of respondents and responses are lower (about 20%) than could be expected from those reported in the literature (c.f. section 2). We assume there are several reasons for this. Most notably, the recruitment process suffered from a number of problems. Due to technical and other problems, there was a very long period (more than two months) between the respondents agreed to participate and the ES actually started. Therefore, some respondents had forgotten they agreed to participate, or could have changed their mind during this period. Furthermore, the ES was intended as a direct continuation of the pre-test survey, and this link was clearly broken because of the delay.

Another reason for the low number of responses was that a few days into the ES period, a software problem led to an excessive number of prompts being sent, which might have annoyed the respondents. After this incident, the response rate dropped to about half of that prior to that problem.

The incentive for participating was several draws of ticket for popular shows and a final draw for a miniTV terminal. Compared to those used in comparable studies (c.f. section 2), this is clearly lower – in [7] the participants were, as an example, offered a reward of 1$ per response.

A subset of the respondents participated in a post test survey. In this the majority of these felt that there were too many prompts per day. This is surprising when comparing to previous studies, [7], [10]. Some respondents were also frustrated with the high amount of similar prompts.

Some experienced problems with their phones having to copy the links from their phones to a regular browser.

Turning to the actual responses, these show a good correlation with the pre- and post-test surveys, except for a few cases as described above. This can be interpreted as confirmation and extension of the findings from the surveys.

As a final conclusion, we stress the importance of the recruitment process and communication with the test respondents as deciding factors for their willingness to continue to participate and respond to an ES test.

6. ACKNOWLEDGMENTS

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Drawing and Acting as User Experience Research Tools

Alexandre Fleury
Aalborg University
Niels Jernes vej 12, 9220 Aalborg Ø, Denmark
amf@es.aau.dk

ABSTRACT
This paper discusses the use of participant-generated drawings and drama workshops as user experience research methods. In spite of the lack of background literature on how drawings can generate useful insights on HCI issues, drawings have been successfully used in other research fields. On the contrary, drama workshops seem to be increasingly popular in recent participatory design research. After briefly introducing such previous work, three case studies are presented, illustrating the use of drawing and drama workshops when investigating the relationship between media technology users and two specific devices, namely televisions and mobile phones. The paper focuses on the methods and discusses their benefits and the challenges associated with their application. In particular, the findings are compared to those collected through a quantitative cross-cultural survey. The experience gathered during the three case studies is very encouraging and calls for additional reports of UX evaluations involving drawing- and theatre-based exercises.

Author Keywords
Acting; drawing; user experience; television; mobile phone.

ACM Classification Keywords
H.5.2 **[Information Interfaces and Presentation (e.g. HCI)]:** User Interfaces – evaluation/methodology.

INTRODUCTION

Exploring detailed aspects of people's life can be done in many ways: Standard ethnographic methods include interviews, activity logging, or remote prompting. These methods help researchers immerse into people's life more or less deeply and over various time periods, from a specific point in time to several weeks, months or even years. However efficient these methods are, they suffer nonetheless from a number of shortcomings, such as being time consuming in planning, conducting and analysing. Sometimes one might need a snapshot of a specific part of people's life from a sample of participant bigger than what can be afforded using the abovementioned methods. Another criticism that these methods can face are the little creativity they rely on. They are indeed not suitable for developing possible scenarios in which technology meets prior personal experiences.

Two motivations for revisiting the UX researcher's toolbox are at play in the abovementioned scenarios: Firstly, decreasing the resources necessary to measure personal user experiences; and secondly to develop possible future use cases for technological products or services based on prior experiences and personal emotions. Tackling the former issue, rapid UX evaluation strategies have been developed and applied. Beebe for instance introduced and defined "Rapid Assessment Process" [3], and Millen further proposed to focus on three key aspects of evaluation design [13]: Focus and key informants (to limit the amount of data collected), Interactive observations (to improve the quality of the data collected), and Collaborative data analysis (to help analysing the data collected).

Concerning the second issue, participatory design workshops are a common way to investigate how people perceive technology and what is expected from it. Additionally, investigating technology use through the lenses of performative art has been recently called for by researchers interested in practice-led research [7] and ubiquitous media [9]. Theatre-based methods are perceived as a promising way of supporting the design process of mobile IT [17] and for gathering requirements, especially with non-tech savvy populations [15].

This paper examines how drawings and acting can support the two abovementioned challenges in evaluating Human-Computer Interaction with technology, specifically with novel television and mobile technologies. On the one hand, drawing tackles the methodological challenge of providing deep insight on test participants' personal matters in an easy way, in a timely fashion, and using a relatively large sample size. The type of personal stories collected and the level of intimacy user experience (UX) researchers can access through drawings will be exemplified through the application of the method to a specific research agenda, namely investigating the relationship between users of televisions and mobile phones and these devices. On the other hand, acting is used here as part of a workshop mixing reflection upon personal experiences with TV and mobile phones, and generation of creative scenarios involving such technology. Prior to acting mini-plays created in groups, workshop participants reflected on their personal relationship with the technology via simple individual exercises, including story creation and drawing. The results from these exercises are briefly presented, in

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order to illustrate the approach and discuss the benefits and challenges of including a theatre-based exercise in a technology oriented workshop.

The studies documented in this paper took place in two distinct cultural environments, namely Danish and Japanese universities. The study conducted in Japan happened during a six month visit to the institution as part of the author's doctoral study. The socio-historical approach to media studies taught at the Japanese institution encouraged the author to investigate technology-free user study tools. Moreover the cultural and linguistic gap experienced during the stay provided an excellent opportunity to try non-verbal UX investigation methods. Denmark and Japan are two ICT societies within which media technology is ubiquitous, thus comparing the findings collected in both countries is expected not only to put forward converging trends and differences in how televisions and mobile phones are perceived and used, but also to reveal culture-related issues in the application of drawing and acting as user research methods.

DRAWING AS A RESEARCH METHOD

Drawings and sketches have been part of humans' communication tools palette since their early evolutionary stage. Whether it is for visualizing specific ideas, expressing artistic inspiration, supporting learning process, or ensuring durable memory, drawings are used almost everywhere. In fact when learning how to express themselves, humans rely on drawings very early, prior to writing. In their first years of life, children learn to use drawings as a communication mediator. At the same time, the child gradually includes writing in the drawings, enhancing clarity in the ideas expressed [1]. The important role drawings play in human development explains the vast academic literature available related to children's drawings and their interpretation.

Simple drawings can help convey complex ideas, especially in the business world [16]. Drawings help clarifying ideas, expressing them rapidly without the need for complex technology, and sharing them openly encouraging discussions. It is further argued that "*the value of visual information lies […] during the action of drawing*", that is during the creation process of the image rather than in the image itself [14]. Mills considers drawing as a visual conversation, for which the performance itself is crucial to make sense of the message conveyed. In design, drawings are widely used in order to illustrate and explore scenarios and ideas through storytelling, and storyboards are considered an efficient and powerful tool for illustrating a succession of events [18]. Exploring people's life, opinions and thoughts through drawing are however less popular.

Recently, ethnographers have used drawings to discuss medical conditions with patients. While using drawings for exploring how people understand illness, Guillemin demonstrated that drawings can indeed generate a broad and in-depth perspective on the study at hand. The author agrees with Mills in saying that studying the drawing produced alone is not enough, but should be complemented by the analysis of the knowledge built by the drawer while creating the drawing [6]. Additionally, Guillemin notes that a drawing is a snapshot of how the drawer understands a subject at the specific time of the drawing. She reckons the limitations of this visual expression tool and argues that drawings should be used as a complement of additional research methods. Guillemin's findings are corroborated by Kearney and Hyle who identified the following benefits and drawbacks of using drawings as a research method for investigating the emotional effects of change in an educational institution [10].

1. Drawings reveal emotional aspects that would not be covered in word based communication
2. Participant focus on the key aspect of their story
3. Drawings needs to be complemented by participant explanation
4. Response to the drawing task varies according to personal and situational characteristic that may be hard to control
5. The lack of boundaries associated with drawing alleviates participants freedom of expression
6. Likewise, researcher-imposed structure determines interpretation of drawings
7. Drawings is suitable for data triangulation when used in complement to other research tools

Furthermore, considering drawings as a support for focus groups involving children, Yuen presented evidence that drawings had the following positive effects on the study outcome [24].

8. It helped create a relaxed and comfortable atmosphere, and released the pressure to answer immediately
9. It enhanced the communication between the researcher and the children by providing further insight on the children's perspective on the topic discussed, as well as offering children the possibility to express more personal experiences
10. It allowed better identification of groupthink and gave each idea expressed an equal chance for consideration

It should also be reminded that drawings can be culturally reflective. In a study comparing children drawings in Japan and the United States, La Voy et al discovered that when drawing people, Japanese children tend to include more details and represent humans larger but with fewer smiles than their American counterpart. These differences are explained by cultural clues of how children are raised in both societies. [22]

PERFORMING USER EXPERIENCES

Similarly to drawing, acting is deeply integrated into people's life, regardless of the nature of acting (as an artistic performance or as part of everyday routine). Until 2000 acting was primarily used as a research method in social and health science [23]. More recently, designers started including role playing in participatory design

workshops occurring at early stages of the design process. In particular a group of Finnish researchers have generated a large body of work regarding the use of drama and dramaturgy in user-centred design processes. For instance Metho et al. introduces state-of-the-art theories, methods, as well as case studies in [12]. In their work, they have identified seven types of drama-based workshops, among which the Drama workshop inspired the activities further described in this paper. Drama workshops consist of a set of collaborative activities (discussions, improvisations, physical exercises, etc.) used to explore a specific issue through the participants' experiences and emotions. Examples of such workshops are reported in [20]. Titta et al. explored the issues associated with retirement using a mixture of user-centred product concept design (UCPCD) and drama-based methods. The methodological lessons learned during the experiment encourage the use of drama-based techniques in complement to more traditional approaches for several reasons. Firstly, the emotional and social dimensions of interaction are more thoroughly investigated. Secondly they provide users a way to explore their experience from a different viewpoint, which can be beneficial especially in early design phases. Last but not least, the ease of conducting drama-based workshops was put forward.

Performance-based user activities are also part of the future technology workshop described in [21]. This collaborative, participatory design technique aims at providing direct input for the design of disruptive technology by relating users to the technology in a pragmatic, open-ended, cost-effective way that requires minimal participant training. It involves participants in a sequence of seven activities, including among others, brainstorming, prototype design, scenario building and role play. The purpose of this latter activity is to contextualize the futuristic and contemporary technology models previously identified during other sessions. The present paper adapted this approach from focusing on a far future to introduce instead an altered, challenging version of current reality.

Even though the Japanese literature available in English concerning performative user experience research is scarce, it seems that theatre-based techniques have been employed in a number of UX research projects. For instance in [8], the authors relate how test subjects first identified typical scenarios of their work and acted out a selection of them in situ. This enabled the research team to thoroughly understand how people relate to these mundane tasks and better inform future design of supportive technology.

Finally, as Metho et al. argue, "the different dramaturgical and performative forms bring up elements that would otherwise go unnoticed" [12]. As a concluding remark, most studies agree on judging the role of facilitator crucial and impacting results. As developed in the next section, this impact is minimized during both drawing and acting activities, letting participants take ownership of the expression medium and use it as they feel.

CASE STUDIES

This section presents three case studies of using drawing or a combination of drawing and acting as a mean of understanding the relationship between media technology users and two media devices: televisions and mobile phones. The first case served as a pilot study in order to test and improve the drawing only approach. Nevertheless, it also generated valuable data which can be analysed. The second iteration builds from the pilot study and was conducted in a different cultural environment for potential comparison. The final case study makes use of both drawing and acting in a drama workshop involving individual and group exercises.

Pilot Study: Project Seminar in Japan

Setup and participants

The pilot study (CS1) took place as a social event during a three-day project seminar. All participants knew each other, for the project had been running for several years. After the second day's dinner, everyone gathered in the meeting room where further discussions about the project were to take place after the drawing experiment. Participants were handed a set of paper sheets. On the first sheet, a description of the author's project and the purpose of the study reminded the participants about the experiment. The four remaining sheets contained a few lines of instructions and a large empty square on the rest of the page for drawing. Pens of various types and colours were available to all participants, who could use any combination of them. Participants were sitting on the floor either in small groups or individually. Interaction between participants during the experiment was possible but not mandatory. Thirty minutes was allocated to the entire test, including introductory speech. The sets of paper sheets were collected after each participant completed his/her drawings, in order to limit potential alterations. Twenty-one participants took part in the pilot study. At thirty-six years old in average, they were mainly males (17 against 4 females), and their occupation was closely related to the academic world.

Tasks

The study investigated participants' relationship with TV and mobile phone separately: The two first sheets focused on television and the two last on mobile phone. On the first sheet participants were asked to draw the layout of their house, indicating the media devices regularly in use. Additionally, participants were instructed to illustrate media devices used simultaneously. For the second drawing, participants were asked to illustrate an impressive memory related to television. It could be a memory about anything that marked them somehow deeply. The drawings concerning the mobile phone followed the same approach: First participants had to picture themselves, depicting the mobile devices they carry around with them. Then they should recall and illustrate an impressive memory associated with their personal mobile phone.

Results

Analysing the data collected solely based on the drawings can be a difficult exercise and has been argued to be insufficient [6]. Nevertheless, as a first step into the analysis it leaves the opportunity to interpret participant answers and identify trends and categories. Later this can be used for selecting a few participants for further examining representative contributions.

Focusing on home media usage, the analysis should filter out the excess of information that appears in most drawings. Sketching the layout of the home is only the support task for studying where and how media devices are used in the home. This comment is actually valid for all drawings regardless of the topic at hand. As illustrated in Figure 1-(a), Japanese home drawings are usually complemented by text clarifying a device, piece of furniture or specific use situation. As the figure also illustrates, sometimes the drawing integrates information that does not relate directly to the topic (such as the location of windows or various rooms in this example). In such cases the researcher needs to separate primary information, directly relevant and to be immediately analyzed from secondary information, which may still be useful to complement the primary findings at a later phase of the analysis.

When asked to depict a memory related to television, the majority of Japanese participants portrayed memories related to the TV content, and little about the device itself or the social interaction around it. Half of the memories involved the participant alone, and one third involved family members (Figure 1-(b)).

Self-depicting oneself leads to reflecting on one's behaviour, which some Japanese participants expressed through there drawings. Additionally, four participants specifically represented several situations in which they carry mobile devices. In general, participants depicted themselves carrying 2.5 mobile devices (such as mobile phones, computers, or music players). A few considered more exotic devices (e.g. watch, transportation cards). Concerning mobile phones, they were mostly located in a pants pocket, often in a bag and sometimes in a jacket pocket. Figure 1-(c) is an example of typical self-depiction.

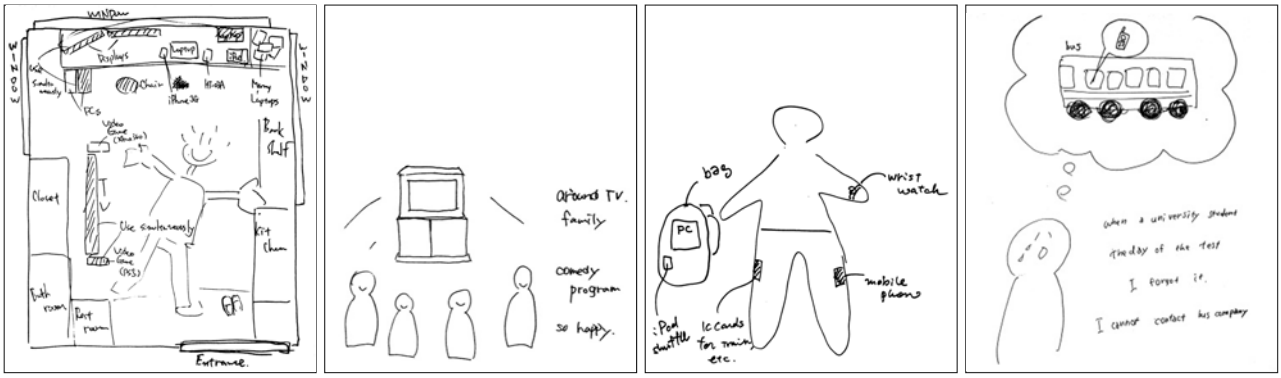
Finally, memories about mobile phones mostly related to experiences where the device had been broken, forgotten, lost, or otherwise misused (as depicted in Figure 1-(d)), as well as specific use situations. Those memories were mostly associated with negative feelings, rather than positive or neutral ones. Even more than with memories involving TV, mobile phone related memories concerned the participant alone.

Study 2: Graduate Course in Denmark

The second experiment (CS2) repeated the pilot study in a different cultural context, and included a few minor modifications in the setup. The participants also differed in the second study as all were graduate students attending a User Experience Design course. The tasks however remained strictly identical to CS1.

Setup and participants

This study took place during a two-hour lecture introducing students to qualitative methods for user experience research. The exercise was conducted after a short break at the beginning of the second hour of the lecture. The lecturer gave a brief and general introduction to the method before starting the exercise, which lasted about 20 minutes. The task sheets differed from the pilot study by the size allocated to each drawing. In order to avoid potential blank page syndrome, two drawings were expected per page, instead of one per page during the pilot. Participants were sitting at their desk as during the lecture and could interact between each other. Pens were distributed to participants who didn't have one. Thirty-seven graduate students took part in the second study. They were again mostly males (26 against 11 females) and 24 years old in average.



(a) (b) (c) (d)

Figure 1. Drawings collected during the Japanese project seminar illustrating a home and media devices in use (a), an impressive memory involving TV (b), a self-depiction including mobile devices (c), and an impressive memory involving mobile phone (d).

(a) (b) (c) (d)

Figure 2. Drawings collected during the Danish graduate course illustrating a home and media devices in use (a), an impressive memory involving TV (b), a self-depiction including mobile devices (c) and an impressive memory involving mobile phone (d).

Results

Drawings from the Danish students could be categorized in a similar way than the Japanese ones. The home drawings can be classified in two categories according to the amount of details included. The range of complexity between drawings varied considerably from minimalistic (illustrated in Figure 2-(a)) to very detailed, a short majority belonging to the former category.

When it came to remembering a remarkable event related to television, Danish students mentioned the device itself in majority, mostly illustrating scenes of use or acquisition (illustrated in Figure 2-(b)). Memories related to the TV content as well as the surrounding social environment were also mentioned. The people involved in most of these memories as well as the associated feelings were unclear and were matter of interpretation. This would call for further discussion with the author.

Danish students represented themselves carrying 1.8 mobile devices in average, mostly focusing on the cell phone, sometimes complemented by a laptop or music player. Most participants represented themselves using their mobile phone, hence carrying it in their hand (as illustrated in Figure 2-(c)). The second most popular location for carrying mobile phones was the pants pocket. A surprisingly representative number of drawings pictured the user and devices separately.

Finally, memories related to mobile phones referred equally to situations in which the device was broken, lost, or misused, than to specific use situations (as illustrated in Figure 2-(d)). Those memories involved mostly the participant alone. As with TV-related memories, the feelings associated with mobile phone memories were very hard to identify without making assumptions based on the content depicted.

Figure 3. The scale of emotions used to described feelings: anger – sadness – neutral – surprise – joy

Study 3: Drama Workshop in Japan

The third study (CS3) reported in this paper illustrates the use of drawing as scenario building and acting as research methods to generate creative use of television and mobile technology based on prior personal experiences with those devices. The workshop took place during the author's stay at the foreign institution mentioned in introduction.

Setup and participants

In this study, 12 undergraduate and graduate university students (aged 26 in average) engaged in a series of individual and group exercises, during a four hour drama workshop. Most of the participants knew each other beforehand, even though they were not necessarily studying together. The workshop took place in a meeting room, in which tables and chairs were arranged to suit groups of 3-4 people working together. In general the workshop followed the approach described earlier as a drama workshop, but the chosen exercises were inspired by McCarty's work on enacting participatory development [11] and Theodor's creative method workshops [19].

Exercises

In order to get the participants in a creative and playful mood, they first took part in an icebreaking group exercise. All participants wrote down a simple sentence about television or mobile phone following the structure "*I <do something with the device>, to <purpose of doing it>*". Half of the participants were asked to create such sentence related to TV, and the other half to mobile phones. The paper sheets on which participants wrote their sentence was then cut at the coma, and the second parts redistributed so each participant would get the ending of a sentence corresponding to the device they did not write about. Each participant then read out loud the newly created sentence, and very briefly tried to argue for its possible meaning. The following is an example of such sentence: "*I change channel to 8, to separate a little bit from business mail*".

Then, the first individual exercise inquired participants about their personal attachment to television and mobile phone, respectively. For each device, participants were

asked to (1) indicate on a scale of emotions (anger, fear, neutral, surprise, and joy, as depicted in Figure 3) which ones would likely apply to them in case they didn't have the device anymore, (2) write down on cards up to three functions of the device they consider essential, and (3) select among a list of 36 adjectives those which best describe the device according to them. The emotion scale is derived from cross-culturally validated Ekman's list of six basic emotions [4][5], from which disgust and fear were discarded as deemed irrelevant in a technological context. The list of adjectives consisted of 18 pairs of bi-polar descriptors of objects, such as public and private, hot and cold or polite and rude.

In the second individual exercise, participants integrated the functions they previously identified for both devices into illustrated mini-stories. They were provided with a set of cards representing a problem (lost, fire, late, etc.), a location (workplace, plane, restaurant, etc.), a mood (anger, fear, joy, etc.), and a social setup (family, best friend, colleagues, etc.), which they should integrate in their stories. The purpose of randomly setting up the scene for participants was to provoke them into imagining using familiar technology in unfamiliar setups. To illustrate their stories participants had at their disposal a drawing notebook each, pens of various types and colours, scissors, and empty cards to possibly add functions.

After a 20 minutes break during which participants relaxed and chatted, random groups of three were formed. As a first group exercise, each participant should display and explain his/her story to the other two group members, who would discuss it briefly. Then they should collaborate to create a common story to be later performed in front of the other groups, inspired by the three personal ones. They were allowed to discard or add elements to the story, but were encouraged to keep as many of the technological functions as they could. Finally, the room was rearranged and a scenic space created, on which each group acted out their mini-play, each lasting about five minutes.

Results

Analysing the data collected during this workshop consisted in two parts. Firstly, studying the answers from the first individual exercise related to the relationship between participants and mobile phone/TV. Secondly, tracking the evolution and possible modifications of the individually selected functions and their potential inclusion in the mini-stories and mini-plays.

Personal relationship with TV and mobile phones

When asked about their anticipated emotions if TV and mobile phones were not accessible to them anymore, participants reacted differently for both devices. While the imagined loss of television left the participants largely neutral, despite mild sadness and surprise, the idea of not having a mobile phone anymore provoked great sadness and mild anger.

The analysis of the selected adjectives reveals further discrepancy between the perception of mobile phones and TV. The top five adjectives associated with each device are:

- **Television**: Passive (75%), Loud (50%), Exciting (42%), Public (42%), and Lazy (42%)
- **Mobile phone**: Convenient (92%), Personal (84%), Private (67%), Small (50%), and Active (42%)

If in general these findings were to be expected, it confirms nevertheless current general opinion about what TV and mobile are about in a heavily connected society with ubiquitous media access: Namely the passive and shared consumption of TV content, contrasting with the discrete, active use of the mobile phone that is always carried around. Additionally, the difference in amplitude of the replies is worth noticing. Similarly to the previous exercise, participants reacted more strongly about the mobile phone characteristics than they did for the TV ones. This indicates a strong relationship (personal and private) with mobile phones, compared to a more distant connection (due to its public and loudness features) with TV.

Technological functions, mini-stories and mini-plays

Each participant identified functions s/he considers essential for mobile phones and televisions. Then they all created mini-stories around these functions. Finally these mini-stories inspired the groups of 3 participants in creating and acting out a mini-play. These mini-plays thus include some of the functions previously put forward by each participant. Tracking down how the functions have been used and/or modified throughout this creative process not only provides a better understanding of how important they are for users individually and as a group, but also informs about the group dynamics during such an activity.

In average each participant thought about a little less than 5 functions to be essential for both devices. The 56 functions named can be categorized into the following eight clusters based on their similarity: Access to information, Specific use, Communication, Design + specification, Entertainment + relaxation, Secondary function, Music + sound, and Others (unspecific, etc.). Surprisingly, even within the clusters, the functions cited are little redundant, and instead tend to cover various aspects of the same issues.

When creating their individual mini-stories, participants used most of the functions they identified as essential, discarding only 13% of them. Three quarters of the functions kept were then used unmodified in the mini-stories, while the rest was modified to better fit the story. At the end of the group work however, only a third of the original functions were kept untouched, the rest of the 32 remaining functions being modified during either of the exercises. Additionally, if participants only used the functions they generated in their individual mini-stories, 15% of those used in the group mini-plays were new ones, created to fit the purpose of the plays. These observations illustrate the participant willingness to reach group consensus, when merging their ideas together, contrasting with their intent to use all the elements they have at their disposal when creating their own stories. Examples of mini-stories are given in Figure 5.

Regarding the content of the stories, the degree of realism evolved between individual stories and group plays. If all individual mini-stories are highly realistic in terms of environmental settings and how the technology is put into use, the group mini-plays were much more surreal, especially with regard to the scene setups. Furthermore the groups used the context cards in different ways: Three groups reused 67%, 83% and 100% of them, while the last group only used one card unmodified to fit the story, while half of the other cards could only be somehow considered implicitly in the play. Extracts of the four groups mini-plays are displayed in Figure 6.

DISCUSSION

The following topics emerged while evaluating the data collected through the three studies. They aim at informing HCI researchers interested in adopting drawing and/or drama workshops to investigate UX with technology.

Personal Matters

It seems that drawing facilitates the expression of personal matters. In both Japan and Denmark, intimate stories were depicted in the drawing-only workshops. We argue that these stories would take longer to collect through verbal interviews, as the act of drawing provides both a personal sphere to reflect in (centred on the paper sheet), and time to think and organize one's thoughts. It is further argued that drawing provides an opportunity for reflecting on one's behaviour, which opens for further discussions with the drawer. For instance both Japanese and Danish participants realized that they were sometimes using two phones at the same time and that could be considered strange.

Ubiquitous Mobile Phones

Cultural factors should be considered when asking people to remember a remarkable event related to a specific device. Some participants in both Japan and Denmark (two countries with a high rate of always-on users) expressed their difficulty to think about such a memory related to mobile phones. In fact they considered the device to be so embedded in their everyday life that finding an extraordinary event linked to it was hard. The very strong personal character of mobile phones was also noticeable in all case studies: Participants reacted more strongly when inquired about phones than about televisions.

Japanese vs. Danish Drawings

For what concerns the memory-based drawings (CS1 and CS2), in general Danish drawings were more ambiguous and harder to interpret on their own than the Japanese ones. For instance it was easy to determine whether a Japanese memory was associated with positive, negative or neutral feelings. On the contrary drawings collected in Denmark were ambiguous and could only be guessed. In both countries most memories related to mobile phones referred to the use or misuse of the device by the participant alone. However when remembering an event related to TV, Japanese participants referred mostly to the TV content, while Danes focused on the device more frequently. Japanese also visibly experienced these events either alone or with family members, while Danes were more ambiguous on the matter. Regarding the story-based drawings (CS3), all but one of the stories were easily understood without further insight from the drawer.

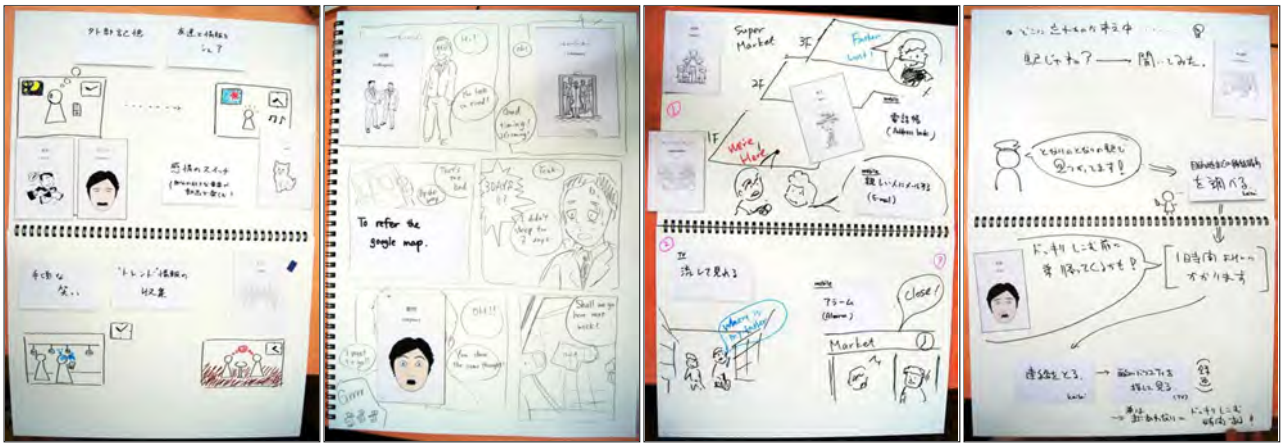


Figure 4. Extracts from individual mini-stories created by four participants.

Figure 5. Extracts of the mini-plays acted by the four groups.

Acquaintance among Participants

Even though the participants produced the drawings (including as mini-stories) on their own, the presence of colleagues, friends or strangers around might influence productivity and the level of attention to details. However, the drawings collected during the three case studies seem to indicate no such effect. It could even be argued that both familiar and unfamiliar social surroundings may positively influence how people draw. In a familiar social setting, one might want to impress or amuse friends, and when surrounded by strangers, one might want to appear assiduous. In both cases, the attention given to the drawings might be high. Nevertheless, consistency bias may occur in case of participants exchanging heavily during the study.

When grouped together to perform a collective creative activity, it is important that participants feel comfortable enough to share their ideas and voice comments toward other's ideas. This can be achieved by either selecting participants who know each other prior to the workshop, or by creating an atmosphere supporting constructive group creativity. These strategies were applied in the case studies presented in this paper as follows. In the three case studies participants knew each other beforehand. Additionally, CS1 participants' attitude was oriented toward creativity as part of the event they were involved in (a project seminar involving group reflective activities). In CS2, participants' reflective potential was triggered as part of the learning process they were engaged in (a course in UXD). As for CS3, an icebreaking game invited participant to think creatively from the onset of the workshop, and a general playful atmosphere was later maintained by the facilitators. These have been proven successful strategies to encourage participation. The level and way to establish playfulness need however to be adapted to the cultural and social characteristics of the participants, in order not to appear brusque, inappropriate or irrelevant.

Interpreting Results

Analysing qualitative data such as drawing and theatre plays can be challenging. Based on the literature and the experience gathered while conducting the activities documented in this paper, a few guidelines concerning result analysis are discussed in the following paragraphs.

Participants might respond negatively at first when asked to draw, as they might not feel comfortable about their drawing abilities. "*But I can't draw…*" was a typical reaction during the three case studies. It is essential to make clear that the "quality" of the drawing for this activity lies not in its artistic value, but rather in its ability to convey an idea, to express a memory, to illustrate a setup or a fact, etc. Moreover it is necessary to stress that the drawings are not judged in any way, they are merely a support for expression. Encouraging participants to use stick figures and words helps fight their possible discomfort or reticence. After this first barrier is overcome and participants completed their drawings, self-critiques disappeared and only a cheerful mood and the joy of having participated in a playful activity remained.

Similarly, the guidelines for the mini-plays created in the third case study were loose and encouraged the groups to be creative. In fact, the frame of the stories was implicitly defined by the previous activities conducted in the workshop, and as a result all groups stayed within the scope of the workshop theme. They used the opportunity to express themselves and this led to discovering potential use cases of technology in unconventional situations.

Being aware of the events unfolding at the time of the study is also important as they might influence participants involved in a creative group activity: The largest the event the higher the probability of impacting the group's creation. This phenomenon was particularly visible in the third case study, which took place in Japan less than two weeks after the March 11, 2011 disaster in the Tohoku region, which greatly affected the whole country. Especially the group plays reflected the difficult time, as all involved a dramatic plot and three out of the four plays explicitly included the massive wave of earthquakes that were still shaking the country at the time of the workshop. Individual exercises focusing on personal experiences such as the two first case studies and the first exercises in the third case study were not impacted by such event. They specifically focused on personal experiences and therefore referred to events from a relatively distant past.

Comparison to quantitative results

After performing the activities related so far in this paper, an online survey was conducted among 116 Danes and 102 Japanese to investigate various aspects of their everyday experience with TVs and mobile phones. Some differences between the two populations are reported to further argue for the need to consider cultural factors when conducting UX research. The survey mostly aimed at exploring interest

and behaviors related to second screen activities, however these issues will not be discussed here as they are irrelevant to this paper. Instead, we shall focus on the more generic UX aspects with mobile phones and television also reported in the survey and overlapping with the topics explored though the drawing- and drama-based workshops. In that regard, the survey respondents were asked to:

- name the most important features they consider when buying a new mobile phone
- describe what they like and dislike about their mobile phone and television (separately)
- express their expected feelings if they had no longer access to their mobile phone and television (separately)

Important buying factors are comparable in both countries: features (such as camera, calendar, and music player), design and price are the top three criterion influencing device acquisition. The features cited are secondary functions of the mobile phone, which were already found important for workshop participants (in CS3); although to a lesser extent than the primary, communicative, functions. The importance of these primary and secondary functions was confirmed by what respondents reported liking and disliking about their mobile phone, as functions such as calling and accessing Internet were frequently mentioned. This is also coherent with previous findings: The importance of mobile phone functions in the perception of the device has been previously established for Japanese and North Europeans (Swedes) in [2].

Then, respondents were asked to select the emotions that best match their expected feelings in case they could not use their mobile phone any longer. They could choose among Ekman et al.'s six basic emotions (this time including disgust and fear, as well as the possibility to freely name any other emotion). Both Danes and Japanese chose sadness as the dominant emotion they would most likely experience if they were suddenly deprived of mobile phone, confirming the results obtained in CS3.

Then they were asked to imagine that they had no longer access to their television. As previously, sadness was mostly chosen in Japan and Denmark. However, an especially large number of respondents (34% of Danes and 48% of Japanese) found that none of the six basic emotions suggested represented well their expected feeling in this situation. A potential explanation is actually the lack of reaction that would experience the respondents with no longer TV access, as further indicated by the additional emotions freely cited by participants. Indeed, indifference was frequently mentioned explicitly, which aligns with the results collected in CS3.

Finally, respondents described what they like and dislike about their television. Answers collected in Denmark differed visibly from those collected in Japan. The two predominant sources of positive feedback in Denmark are the content and the purpose of watching TV (catching up with news and being entertained). This matches the two functions mostly cited during CS3. In Japan however, the TV's performances are the main source of satisfaction with television, followed by content and purpose. The two populations also differ in the features they dislike about TV: It is considered a time waster by Danes, and the content available is a source of dissatisfaction for them. Japanese complain mostly about the content available and the specifications of their TV set. Often TV is appreciated for its relaxing or informative purpose but watchers tend to get caught up and keep on watching even though they lose interest in the programme, leading to frustration. When comparing these findings with those extracted from the drama workshop, the Danish survey respondents agree with the Japanese workshop participants in the general functions they appreciate the TV for, while the Japanese survey respondents pointed out more specific topics.

CONCLUSION

This paper documented three case studies utilizing drawing and a drama workshop to investigate personal relationships with television and mobile technology, as well as to generate possible scenarios for such technology in a creative approach. To the extent of the knowledge acquired while conducting the two first case studies and during their analysis, drawing as a stand-alone technique and as part of a drama workshop seems a valuable technique for acquiring qualitative insights on the user experience with technology. The following statements have been verified and summarize the findings of the experiment so far:

1. Drawing helps create a relaxed and comfortable atmosphere in which test participants are willing to express personal matters,
2. The absence of boundaries in drawings further encourages participants to reveal personal aspects of their lives,
3. Responses are influenced by the experimental setup,
4. Analyzing drawings should start by focusing on the primary data (directly relevant to the topic), before possibly including secondary data to broaden the perspective,
5. Drawings should be used in triangulation with other research methods.

The final case study further acknowledged the benefits of drawings when integrated in a drama workshop. It also verified the usefulness of engaging participants in theatre-based activities for visualizing UX with technology. This was successfully investigated in the case of a workshop encompassing self-reflection on personal experience and scenario elicitation in group, conducted in a cultural environment where verbal communication was a challenge.

These findings however need to be further investigated, combined with additional user experience evaluations as suggested in the literature and compared to other inquiry methods in order to assess the performance of drawings as an HCI research tool. A first step in that direction has been documented in the paper, comparing the qualitative results

collected through the aforementioned activities to those emerging from an online cross-cultural survey. The outcome of preliminary comparisons between the approaches demonstrates the benefits of applying both qualitative and quantitative inquiry methods when exploring user experience with technology. Indeed in the present case, not only the qualitative findings re-emerged from the survey and thus further strengthened them, but the two strategies also generated a richer pool of results from which future research questions emerged. In particular, conducting these studies in two distinct cultural settings led to the identification of common traits and singularities, which would be worth investigating further.

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Final draft

Interactive TV: Interaction and Control in Second-screen TV Consumption

Alexandre Fleury[1] Jakob Schou Pedersen[1] Mai Baunstrup[2] Lars Bo Larsen[1]

Aalborg University
Niels Jernes vej 12, 9220 Aalborg, Denmark
[1]{amf,jsp,lbl}@es.aau.dk; [2]mbauns06@student.aau.dk

ABSTRACT

The integration of television and mobile technologies are becoming a reality in today's home media environments. In order to facilitate the development of future cross-platform broadcast TV services, this study investigated prompting and control strategies for a secondary device in front of the TV. Four workshops provided about 1000 statements from TV consumers trying out working prototypes and engaging in discussions following a semi-structured interview approach. We explored if test participants liked to interact with TV content through a secondary device and which kinds of interaction types they preferred with which content. Overall, we found a clear preference for keeping interactive contents and prompting on the secondary device and broadcast TV content on the primary screen. The workshops generated numerous ideas concerning possible personalization of such service.

Categories and Subject Descriptors

H.5.2 Information Interfaces and Presentation (e.g., HCI) – User Interfaces, *Evaluation/Methodology*

General Terms

Experimentation, Human Factors, Measurement

Keywords

Second screen, iTV, Qualitative Study, Interaction, Prompting, Cross media.

INTRODUCTION

Television-related technologies have evolved vastly lately. TV is changing its form, with the consumer moving from passive reception of one way broadcasts to being a part of an interactive media experience. The TV audience is starting to get used to having a much larger degree of control over the TV content. Simultaneously, smart phones and tablets are making their way into the home. As a result more TV viewers engage in media multitasking activities such as browsing the web while watching TV: in Denmark, 59% report browsing the web on a smartphone of tablet while watching TV, and 45% of those focus on their Internet activity when doing so [8]. Today broadcasters are striving to support this evolution and provide cross-platform solutions to deliver content to their audience [2][13]. Communication between content providers and the end viewers increasingly becomes two-way instead of one way.

From a research perspective, it is therefore interesting to investigate how to successfully combine television and mobile technologies in a cross media, or second screen environment. By "second screen" or "secondary device" we refer to any device (smart phones, tablets, laptops) that allows TV consumers to interact with TV content displayed on a 'primary' screen (typically a home television set). It is fundamental to find out what types of interaction the TV consumers would like to engage in through a second screen application and how this should be designed.

The user study reported in this paper explored at a conceptual level how people would envision interacting with a second screen device while consuming broadcast TV. This paper focuses on how to engage viewers in interacting with live TV content in second screen setups. Furthermore, the question of whether the broadcast content should be separate from the interactive is investigated. These issues are studied through four workshops involving small groups of participants trying out prototypes specially developed to illustrate and challenge typical second screen scenarios.

As a brief outline of the paper, the next section presents related work conducted in the field of second screen setups; this is followed by an elaboration of the methods used to conduct the study; the study setup and data analysis method are presented before the results are reported and discussed. Finally, the conclusion summarizes the main findings and opens for future work.

RELATED WORK

Second screens have been on the agenda of interactive TV researchers since the mid-1990s, focusing on various aspects of the integration of the two devices, from content control to T-learning [4].

In order to investigate if viewers actually want to have the opportunity to interact while watching a TV show, and if this provides added value to the TV experience an experiment with 11 households was conducted in [1]. In this study the households were provided with a second screen prototype with which they were to interact while watching various TV shows for a period of three weeks. The qualitative data collected put forward twelve main topics of discussion, including general comments, liked features and issues. The enhancement of TV experience was found to be due to two factors: (1) the possibility of accessing extra relevant information immediately and after the show; (2) the broadening of the experience to outside

the TV room and to an extended social circle. Synchronization and relevance of content, variety in information sources, filtering of user generated content, and personalization of information were found necessary to ensure the success of such service.

In [3], four major usages of the secondary screen in an interactive digital television environment are investigated: control, enrichment, sharing, and transfer of television content. The latter, also referred to as presentation continuity, has been covered in a recent work investigating four specific methods for transferring video content from a mobile phone to a TV set in a ubiquitous home media environment [5]. The remaining three concepts of controlling, enriching and sharing content will be discussed in the present study.

METHOD

Goals

This study focuses on the second screen set-up, while watching TV in a domestic environment. In particular, we are interested in how to encourage viewers to use the second screen to interact with live TV content, or in other words what are their preferences in terms of prompting strategies? Furthermore, should the broadcast content be integrated with or separated from the interactive content and if so, how?

Methodology

The workshop approach was chosen as it allows presenting complex concepts with relatively simple prototypes. Furthermore a workshop allows gathering a group of test participants in a controlled environment, in which they may try out prototypes under the researchers' control. A workshop can be shaped in a variety of ways thus taking different directions depending on the variables included: duration, number of participants, content, and can include various techniques: interviews, card sorting, discussions or other initiatives relevant for the specific workshop. In our case, a semi-structured interview approach is selected in order to consider any idea brought up by test participants while still covering a set of predefined topics. In order to ensure the reliability and validity of our approach, we employed the 5-step verification process recommended by Morse in [10]: Methodological coherence; sample appropriateness; concurrent data collection and analysis; theoretical thinking; and theory development.

Participants

For qualitative studies of this kind, the recommended number of participants is 5-8, see e.g. [12]. However, to ensure sufficient coverage and validity of the results we repeated the workshop four times with different participants and carefully examined any lack of coherence between the four runs. In total 23 participants were included in the four workshops.

The age span needs to be large, due to the big differences in TV habits, interests, technical proficiency etc. that people have across generations. For the two first sessions we recruited males and females between 35 and 60 years old. University students in their early twenties participated in the last two sessions and were profiled as early adopters. All 23 participants received two cinema tickets as a thank you gift.

Content

The process of choosing the content for the workshop encompassed a total of 11 iterations and included brainstorming, discussions, selection, eliminations and testing of potential content combinations.

The final set of selected TV shows and typical interaction to be experienced by participants through prototypes is:

1. *Who Wants to be a Millionaire* (quiz show) – Answer questions simultaneously with live participants
2. *So Ein Ding* (consumer show) – Participate in a poll about a product reviewed
3. *Aftenshowet* (talk show) – Submit comments related to the program
4. *TV Avisen* (news show) – Retrieve more info about the news items presented in the show

WORKSHOP

The workshop consisted of three main parts:

Part one: The participants tried out four scenarios using different prototypes in order to obtain a clear understanding of the second screen concept.

Part two: The participants tried out two specific prototypes designed to investigate prompting strategies.

Part three: The participants discussed content / control separation by trying out a last prototype.

Setup

The workshop was conducted four times, each with two hours duration. The location was in a laboratory at Aalborg University which contained a conference table with room for six participants. Two facilitators ran the workshops and one media researcher represented the Danish Broadcasting Corporation (DR) during the two first workshops. The equipment in the room consisted of a 55" TV screen mounted to the wall at the end of the table and a number of iOS devices held by the participants (iPads, iPods, iPhones). The TV was connected to a desktop PC giving access to the prototypes on a web server.

The prototypes were developed and implemented as full-screen interactive web-apps. The TV content were pre-recorded clips of the TV shows mentioned in the previous section, and the web-apps content was synchronised with the one shown on TV. Figure 2 illustrates the prototype for the discussion regarding prompting strategies, and Figure 1 the prototype used to discuss content/control separation.

Data Capture and Analysis

Data collection was done with a voice recorder placed on the conference table and two webcams. The data collected comprise about eight hours of audio and video recordings – the latter mainly used for backup.

The first step of the analysis was "Meaning Condensation", i.e. only the essence of the answers and opinions is

Figure 2. Prototype illustrating prompting strategies: Via a ticker on the primary screen (top) or a popup message on the second screen (bottom).

Figure 1. Prototype illustrating separation of content and control: The live program plays on the TV (top), while the second screen displays either the interactive functions alone (bottom left), or with the video stream (bottom right).

extracted and written in short precise phrases [7]. An external person carried out this task to insure against experimenter bias. The condensed data contained approximately 1000 statements.

The second step consisted in coding the statements in order to decompose the data and rearrange it into categories that facilitate comparison between findings in the same category or between categories [9]. The categorization thematized the participants' viewpoints which uncovered essential issues. A coding scheme comprising six categories was developed and implemented for the study.

RESULTS

Statements about long lasting battery time, big screen size, fast system response and general ease of use were coherent with previous findings concerning second screens [1], mobile TV [6], and general usability principles [11]. Results specific to prompting strategies and content/control separation are presented in the next sections.

Prompting: Discreet On the Primary Screen

At first, most participants agreed that prompting should not happen on the primary screen. One said: "*It is annoying to look at prompting on the primary TV screen, and an advantage of being prompted on the secondary is that users have the control and can choose for themselves if they want to look at prompting or not*". However, participants also wondered how one would be made aware of the opportunity to interact with a TV show. E.g. "*I would prefer that the prompting occurred on the primary screen as I don't want to sit with my secondary device all the time waiting for this to happen*". As a result of the discussions, a very discreet prompting, e.g. an icon in the corner of the primary TV screen was suggested. This discussion puts forward an ambiguity inherent to the second screen paradigm: How to involve viewers in a secondary activity that takes away their attention from the primary screen while keeping their focus on the broadcast program?

Connected to this issue, one participant commented: "*I did not look up at the TV at any time, while interacting and watching the TV show on the secondary device.*"

The facilitator then asked if the second screen setup rendered the primary screen superfluous, and there was wide agreement on that this was not the case. This ambiguity is clearly due to the fact that TV consists of both audio and video – and in many cases the audio is quite sufficient for viewers to continue following a TV show even when engaged in other activities, e.g. on the second screen. This is expected to be especially true with low engagement TV shows such as entertainment or sport, which are particularly suited for second screen services.

Content and Control Should Be Separated

Discussions about having the TV show running on the secondary device generated much debate. However, a very

clear conclusion emerged; participants agreed that the TV content belongs on the primary screen and interactive content and controls on the secondary device. Furthermore having both content and control on the secondary device may render the primary screen irrelevant: "*When having the content along with the controls on the secondary screen the primary screen becomes unnecessary*". In other words, this corresponds to just watching mobile TV.

Nevertheless, many of the participants stated that watching TV shows on the secondary device should be an option as it could be convenient under certain circumstances. Scenarios where this was mentioned to be relevant include when leaving the room where the primary screen resides without missing out on the TV experience or when the primary screen is occupied by other viewers watching a conflicting program: *"I would prefer to watch content on the primary screen, but would also like to have the opportunity to watch it on the secondary screen for situations where there is no primary screen available"*. The participants wanted to be able to control if the show should be running on the secondary device, in sync with the content broadcast on the TV screen.

CONCLUSIONS

We have presented a qualitative study of second screen use for TV. We designed and implemented a number of illustrative prototypes and presented those to two user groups in four workshops. Specifically, we addressed prompting strategies and the separation of TV content and interactive content. The conclusions from the study raise a number of design questions regarding the optimal division between primary and second screens.

Specifically, the outcome of the discussion clearly shows that prompting for interaction with live TV content should be very discreetly advertised on the primary screen to redirect viewers' attention to the secondary screen. It is anticipated that the practice of displaying a small icon or slightly animating the TV name's logo would be an efficient yet non-intrusive prompting strategy. Furthermore, the study participants demonstrated little interest in mixing live TV content and interactive functionalities on the same screen, neither the primary nor the secondary. For both age groups, the TV receiver is dedicated to content playback, while value adding interactive services belong to the second screen.

We believe designers of future second screen services linked to live TV content should consider these guidelines carefully in order to integrate the interactive content smoothly into the TV experience. Interactivity would thus become part of the show's flow, increasing not only the entertaining value for audiences, but also their involvement with the show and perhaps their loyalty to the show.

In general, the workshop approach proved to be well-suited as a data-gathering method and provided more in-depth information than e.g. a questionnaire survey, and consumed fewer resources than a corresponding longitudinal field trial. Conducting such study seems the logical next step to the work presented in this paper, providing invaluable insight in an ecologically valid test environment. Another interesting issue to further investigate would be to look closer into exploiting the "audio-only TV viewing" in a second screen context.

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Evaluating user preferences for video transfer methods from a mobile device to a TV screen

Alexandre Fleury *, Jakob Schou Pedersen, Lars Bo Larsen

Aalborg University, Department of Electronic Systems, Niels Jernes vej 12, 9220, Aalborg Ø, Denmark

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ABSTRACT

This article reports on the evaluation of four methods for transferring video content from a mobile device to a fixed television. The methods have been investigated in a Wizard-of-Oz approach through two consecutive studies. The first experiment aimed at collecting general opinions toward such a feature as well as preferences in terms of usability. In general, participants preferred methods that resemble already known interaction paradigms, and argued against the need of moving physically. From the comments collected in the first study, six potential indicators of preference were generated and investigated in a second experiment. The results indicate that *familiarity*, *convenience* and *annoyance* are strong predictors of the preference level of methods for transferring video content from a mobile- to a fixed device. A discussion and potential design guidelines are finally proposed.

1. Introduction

TV broadcasters are no longer only focusing on traditional TV sets when broadcasting content. Large broadcasters such as the British Broadcasting Corporation (BBC) and Zweites Deutches Fernsehen (ZDF) explicitly guarantee that British and German audiences can get free access to services in ways and on devices that suit them, acknowledging that users want potential access to media at all times. In addition, user can catch up on programs for free using online services either at home, or on the move [1,2]. Both BBC and ZDF have launched media portals to facilitate this, namely the 'BBC iPlayer' [2] and the 'ZDF Mediathek' [1]. The platforms enable users to watch live television as well as catch up on TV programs from the past week, which can be done from Internet-connected computers, set-top boxes, media centres and mobile phones. The two services appear to be quite popular among end users: In 2008 The BBC iPlayer streamed approximately 100 TBs of data per day [2] and received 155 million requests in August 2011, of which 9 million were from mobile devices [3]. In the period June–August 2011 BBC iPlayer users on average streamed 144 min of Radio and 69 min of TV per week [3]. Similarly the ZDF Mediathek reported around 15 million viewings per month in 2010 [1].

Broadcasters' intentions of supporting multiple platforms and devices makes good sense as ubiquitous computing is becoming increasingly widespread and popular. A two-month study of 11 mobile information workers in a large Finish IT company showed that work-related tasks on a daily basis were heavily distributed among a wide selection of devices (desktop PCs, laptops and various handhelds) [4]. Similarly, Dearman and Pierce interviewed 27 people from academia and industry and found that ubiquitous computing is present not only at work but also in private homes [5]. On average, the participants had one laptop/desktop PC at work/school and one at home, and carried one cellular device and at least one portable media device such as a digital camera or iPod. Most participants even had a dedicated laptop PC for bringing between work/school and home on a regular basis. In addition to switching between devices for different tasks, the participants were found to increasingly engage in activities that span devices (e.g. using a laptop PC in combination with a

* Corresponding author. Tel.: +45 9940 9894.
E-mail addresses: amf@es.aau.dk (A. Fleury), jsp@es.aau.dk (J.S. Pedersen), lbl@es.aau.dk (L. Bo Larsen).

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desktop PC). Participants in both studies reported that synchronizing information across the devices constitutes a challenge. In order to cope with this, they use a combination of portable media, Emailing, shared directories and server-based services.

Combining the ubiquitous computing scenarios with the broadcasting of content to different platforms and devices enables 'ubiquitous media' as defined in [6]. A typical ubiquitous media environment includes a TV, a laptop PC and a mobile device on which users can either watch on-demand- or live-TV. However, as reported in [5] and [4] an unresolved usability issue exists when trying to merge a media experience across devices: the synchronizing of information. From a user perspective, this synchronization is an issue of maintaining presentation continuity across devices when "transferring" content between these, even though content is not actually being transferred across devices from a technological point of view.

Our contribution to the field of mobile HCI is twofold: Firstly we evaluate the usability of four potential methods for transferring video content from a mobile device to a TV. Secondly, we deduce a set of preferential indicators allowing, at a relatively generic level, to conceptually evaluate additional ways of transferring content between a mobile device and a TV. From these findings a set of simple design recommendations are derived, with the intention of guiding the design and evaluation of such future services.

In the next section, we review previous research within the integration of fixed and mobile devices. We then detail the design, methodology and results of our conducted experiments concerning the transfer of video content from a mobile device to a television. We finally discuss the main findings and provide a general conclusion, and opening for potential future work.

2. Related work

Ubiquitous media and multiple-device environments have recently come to the close attention of scholars from various areas. A tendency from the literature is to study the integration of mobile devices into the television experience from a control perspective – the typical usage being the manipulation of contents displayed on the TV screen from the mobile device, as well as the access to further functionalities on the phone that complement the TV experience.

In particular, the use of multiple devices in the home environment has been the focus of an ethnographic study [7], which investigated media habits at home. After having identified the current and ideal home media use of 27 families, the authors designed an experimental mobile device to control TV channels and display photos on the TV screen. Sharing media content and especially broadcast multimedia files across devices with peers was in fact found one of the strongest drivers for mobile multimedia usage in the home context, findings echoed in [8]. For what concerns complementing the TV experience, it was in a recent empirical study proposed to "put the Electronic Program Guide (EPG) onto everyone's mobile phone" in order to personalize a shared TV in a typical family home [9]. According to the families interviewed during the ethnographic study, being able to access the EPG on their own mobile device and to personalize it allows family members not only to manipulate it without disturbing other TV viewers, but also to help resolving some conflicts with regard to the control of the TV.

Hess and colleagues investigated what they term the "cross-media jump" for social TV applications in [10] using a Living Lab environment and employing methods such as media diaries and creative workshops. Their goal was to collect information about user requirements and preferences for future design guidelines for integrated social media systems. They found that there were "strong demands for an integration of different devices that are available at home (e.g. TVs, laptops, PCs, tablet PCs and Smartphones)". [10, p. 16]. They also identified a need for viewing Smartphone contents on a TV screen, in particular "requirements for a universal access on different devices" and "content need to be shared and accessed between personal and shared devices". [10, p. 18]. However it seems that merging the television and mobile worlds offers more than controlling what is displayed on the TV screen or using the TV screen as a common display.

Providing task continuity between television and mobile devices has recently been investigated in research projects such as Migrantes [11] and OPEN [12]. These projects implemented and tested technical frameworks to support performing media related tasks seamlessly and continuously across a variety of devices. These frameworks implement session transfer mechanisms between two or more devices, which allow users to switch a device and resume the task being performed in the same conditions and without the need to physically connect the devices. Focusing specifically on navigating through an EPG on TVs, PCs and mobile phones, [13] provides user insights on how potential end users perceive interface continuity across such devices. In this study test participants appreciated the possibility to browse the EPG using a consistent navigation scheme on a TV, PC or mobile phone. The reduced complexity of the interaction further pleased the families with which the system was tested.

Recently, the extensive work by Cesar and his colleagues on the concept of secondary screen illustrates the diversity of possibilities offered by multi-device media environments by exploring new interaction paradigms [14]. According to the authors, the possibility to bring media content along on a mobile device when leaving the home TV set has been mainly investigated through a technological perspective, disregarding user studies. Cesar et al. introduce a taxonomy describing user behaviours in a multi-device media environment. The taxonomy includes content control (deciding what and how to consume TV content), content authoring (actively manipulating TV content) and content sharing (socially communicating with others). Relevant to our study is the concept of 'presentation continuity' under the control activity, which allows users to bring their media content along on their mobile device when leaving the room in which the fixed TV set resides.

Table 1 summarizes characteristics of cross-platform studies from the literature reviewed in the previous paragraphs. This list is far from exhaustive; however it spans a wide variety of configurations and perspectives, from ethnographic work

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Table 1
Selection of previous work on cross-platform solutions.

Study	Environment	Content	Transfer strategies	Devices	Frequency
[4]	Work/IT company	Email, calendar entries, office documents	No transfer (using dedicated devices); Server backups (wireless access); Central device; Data mirroring ('view only' on some devices); Two-way sync	Across smartphones, PCs, and laptops	Up to every 5 min
[5]	Work: IT company and university; Home; In-between travels	Mostly document files	Portable media, emailing, sharing directories, third party services	Across mobile devices (laptops, tablets, (smart)phones, cameras, music players, PDAs) and fixed devices (PCs)	Daily routine
[7]	Home	Photos, videos (including TV shows)	Second screen service	Between a second screen device and the TV set	NA – demo during interviews
[8]	Home	TV programmes, ringtones, wallpapers	Bluetooth	Between mobile phones (sharing mobile specific content and TV clips)	Up to over a dozen files per day
[9]	Home	EPG	Automatic Bluetooth pairing	Between the TV and mobile phones	NA – conceptual design
[10]	Home	TV series, YouTube clips, TV show-related material	NA – conceptual discussions	Across TV, laptops, PCs, tablets, smartphones	NA – conceptual discussions
[11]	Home	Application interface	Migration/proxy server	Between mobile devices and TVs	NA – technical implementation
[12]	Anywhere	Application state	NFC (RFID)	Between a mobile device and a large display	NA – technical implementation
[13]	Home	EPG	Unified user interface	Between TV, PC and mobile phone	NA – prototype evaluation
[14]	Home	TV clips, TV show-related UGC (comments, audio, image)	Home media server	Between second screen devices and the TV set	NA – technical implementation

to technical implementations. Borrowing from the scenarios investigated in this representative body of work, the study elaborated on in the next sections focuses on the home environment, in which video material is transferred from a mobile phone to a fixed TV set, via a selection of four interaction schemes.

2.1. Commercial examples of ubiquitous media equipment

Recent software solutions such as Apple's Bluetooth File Exchange, Infinite Labs' Mover[1] or Bump Technologies Inc's Bump[2] app allow over-the-air transfer of content such as photos, videos or presentation documents between paired devices in a seamless way using innovative interaction paradigms: Apple's solution relies on the popular drag & drop scheme while the latter two apps implement unusual schemes. With Mover, Macs and iDevices (iPad, iPod Touch and iPhone) owners can transfer contacts, photos, videos or files by flicking the icon representing the file on one device toward the other device, as illustrated in Fig. 1a. In addition to the above mentioned file types, users of the Bump app can exchange apps, message, and calendar entries as well as interact through social networks by holding the devices and gently bumping them into each other as shown in Fig. 1b.

Ubiquitous media is also facilitated by hardware solutions such as Seagate's GoFlex Satellite™ Mobile Wireless Storage[3], which can store and stream wirelessly hours of videos to any device equipped with a WiFi connection.

1 http://infinite-labs.net/mover/ (May 6th, 2012).
2 http://bu.mp/ (May 6th, 2012).
3 http://bit.ly/kZufq4 (May 6th, 2012).

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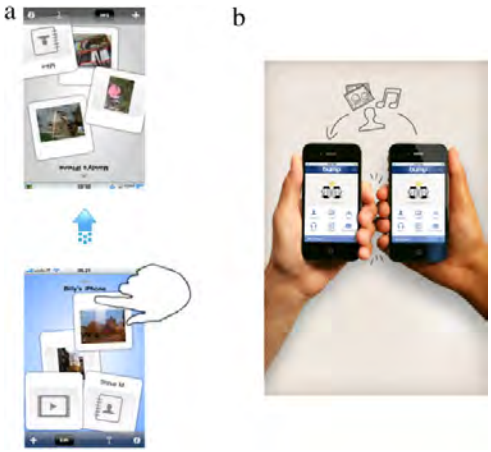

Fig. 1. The principle of transferring content using the Mover app (a) and the Bump app (b).
© 2011, Bump Technologies, inc.

Finally, one should mention solutions such as the Samsung SMART VIEW Android app[4], which allows not only controlling TV from a smart phone, but also watching TV content synchronously on the phone. The app also turns the phone into a game controller and a QWERTY keyboard to interact with the other apps accessible on TV.

3. Video transfer from a mobile device to a TV

In the previous sections we have investigated a number of scenarios presented in the literature and established a strong need for cross-media integration and in particular the requirements for transferring content from one media device to another. Solutions to this problem are the focus of the remainder of the article. By focusing on this issue, we will not address for example the social context in which the transfer occurs or different types of contents (e.g. user generated, stored video, live TV). While these questions are of course important and we acknowledge that they may influence user's preferences to some degree, we believe that a de-contextualized study will yield results that are generally valid and applicable and can be transferred with little or no adaptation to the individual use cases.

3.1. The smartphone as a TV control device

Several of the above-mentioned studies revolve around the Smartphone as a media and control device. For example, [10] involved the design of smartphone mockups for cross-media scenarios and investigated how users perceived the potential conflicts between sharing content between the (private) Smartphone display and the (public) TV screen. Indeed, the Smartphone seems to be the ideal ubiquitous device for device control and sharing content, as already pointed out in 2006 by Ballagas in [15]. In addition to having access to social media, such as Facebook and Twitter, email, chat, etc., as well as the capability to display video, the Smartphone is equipped with the necessary sensors (e.g. accelerometers), communication channels and computing power to perform any required task.

Despite a number of technical solutions investigated to enable presentation continuity in ubiquitous computing environments (e.g. in [16]), it seems that no user studies have been conducted so far to validate these solutions against potential end users.

Our approach tackles the problem from the users' perspective only, and does not consider technical requirements or limitations.

3.2. Transfer methods

Inspired by the work of among others Peng [17], Rukzio [18] and Scheible [19] four sets of actions for handing over content were evaluated in terms of usability. The methods were chosen to span interaction paradigms already in use in a living room for e.g. console games, set top boxes and TV EPGs. The methods were selected with an eye to what is technically feasible with available platforms, such as smartphones. Furthermore, the methods must be very simple, intuitive and easy

[4] http://bit.ly/mRiBG2 (May 6th, 2012).

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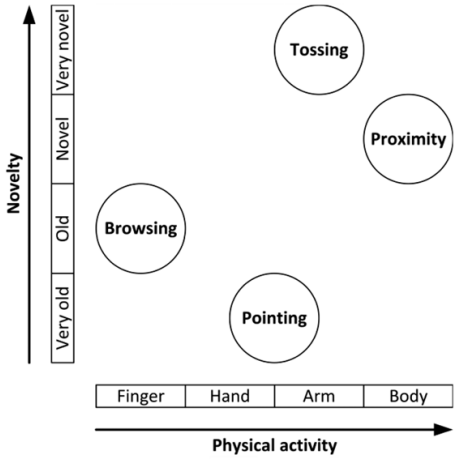

Fig. 2. Distribution of the four selected transfer methods according to their novelty and the physical activity involved.

to grasp and remember for users and should be perceived as a natural extension of the current remote control paradigm of media devices. This requirement rules out more complex and indirect solutions such as navigating a menu structure. Based on these criteria, we chose to include four methods in the study, denoted "Tossing", "Proximity", "Pointing" and "Browsing". These are presented in more detail below.

3.2.1. Tossing

This action encompasses a method with which the user literally 'tosses' the content from a mobile device to a fixed one, conceptually similar to interacting with the Nintendo Wii. Previous research has shown that 'tossing' as means of interaction is fun to use, although slightly difficult to grasp [19].

3.2.2. Proximity

Conceptually similar to regular short cable connections, the user here has to physically approach a fixed device with the mobile device in order to transfer the content. Previous research has shown that users in general are quite willing to use 'touching' as a means of interaction with devices when such devices are nearby, especially when security issues exist or when the risk of ambiguity is a concern [18]. In the present case, the user is not required to bring the devices to actually touch one another. The proximity criterion is similar to NFC, about 4 cm.

3.2.3. Pointing

With this action inspired by Point-and-Connect [17] (which relies on the remote control interaction paradigm), the user simply points at the device that is to 'take over' the playback of the video from the mobile device of the user. When pointed to a compatible device, its name appears on the mobile for the user to click on in order to initiate the transfer of content.

3.2.4. Browsing

Here the mobile device scans for nearby (i.e. in the same room) equipment and generates a list of devices capable of taking over the presentation of content from the mobile device. The user then selects a device from this list and the handover is initiated. Previous research has shown that browsing may be seen as a very technical way of interacting with devices and that users therefore tend to avoid it when possible – unless the device in question is outside touching or pointing range in which case browsing would be acceptable of means of interaction, [18]. However its similarity to searching for a file on a computer makes browsing a natural option for initiating content transfer between devices.

It is not hard to suggest other methods, such as a touch screen gesture to "slide" content from one device to another, as implemented in the Mover app. However, the four methods presented above have been chosen because we believe that they span various levels of novelty and physical activity while maintaining a comparable mental effort and therefore are representative of other methods as well, as depicted in Fig. 2. The assumed associations between the methods and various common multimedia equipment (Tossing–Wii, Proximity–cable, Pointing–remote and Browsing–computer file systems) describes an increasing level of novelty based on the time the equipment has been available to mass markets, thus ranging from very old (Pointing) to old (Browsing) to novel (Proximity) and to very novel (Tossing). Similarly, the physical gestures involved in the methods represent an increasing level of activity ranging from finger (Browsing) to hand/arm (Pointing) to

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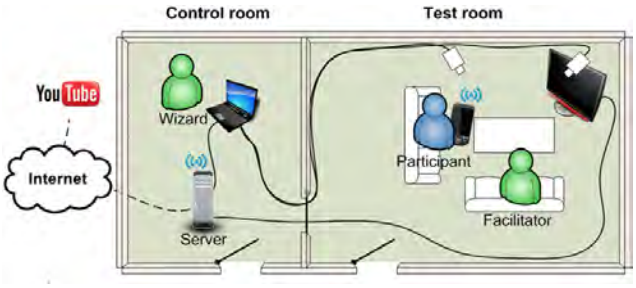

Fig. 3. Technical set-up of the experiment.

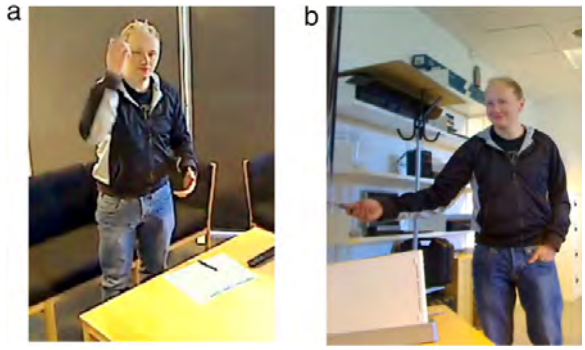

Fig. 4. Snapshots of the experiment as recorded by the control cameras for the Tossing (a) and Proximity (b) methods. Pictures reproduced with permission.

arm (Tossing) and to body (Proximity). Finally, from a cognitive perspective we assume a constant (low) level of mental stress generated by performing the four transfer methods, meaning that the methods are comparable in this regard and similar to e.g. selecting a channel on a remote control. As a result, potential additional methods such as the Mover app in this case are arguably represented in terms of those three parameters and their inclusion to this study is expected to provide little additional benefits.

4. Experimental set-up

The content transfer experiment was partly conducted as a Wizard-of-Oz (WOZ) setup. While the Browsing transfer method was fully functional, the remaining three transfer methods were (transparent to the participants) simulated. Thus, no participant experienced errors during the execution of any of the transfer methods. A semi-automatic prototype was developed, allowing video content to be 'transferred' between a mobile device and a large flat screen TV, based on the actions of the test participant.

The developed prototype is a web-based solution that coordinates the content to be shown on either target device. Both the mobile device (an HTC 'Tattoo' mobile phone running Android 1.6) and a PC hooked up to the TV screen connect to a web server, as illustrated in Fig. 3. A YouTube video feed embedded into a web page was used as content. On the mobile device, four user interfaces have been developed following a consistent look-and-feel to proceed with each transfer method.

The participant sits with the facilitator in the test room. Only seeing the mobile device and the flat screen TV, the participant is lead to believe that (s)he can interact directly with the devices and does not know that they actually are interconnected through a server. The cables in the test room being hidden, the participant is also not aware that a wizard is observing his/her actions from the control room and accordingly selecting on which device to show the video feed.

When the participant initiates a transfer of content, the wizard instructs the server to stop the video on the phone and starts it on the TV at the correct point in time. Two cameras (with integrated microphones) record the participant actions and movements from two different angles as exemplified in Fig. 4. Not only does this allow the wizard to base content transfers on detailed observations of the participant but also provides detailed material for subsequent studies of the participant behaviour.

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Fig. 5. Interface for Pointing, after the participant correctly pointed the phone at the TV screen.

4.1. GUI design

The graphical interface developed for the mobile device deliberately follows a very simple design in order to keep the focus on the interactions scheme instead of drawing attention to the graphical user interface (GUI) itself. A four-button menu lets participants first select which transfer method they shall experience. Fig. 5 illustrates the interface for the Pointing method, displaying the name of compatible equipment when it is pointed at with the phone.

In addition to the mobile phone interface, a control panel was developed in order to let the wizard control the experiment remotely. This web interface allows the wizard to control the visibility of compatible equipment that can be detected on the mobile device. Through this interface, the wizard can also specify which device is to play the video.

5. Experiment I: Deducing preference indicators

5.1. Participants, tasks and interaction

23 university students were recruited for the first experiment, aged 22 years on average. Most participants (21) were males and all reported having at least a medium or a high level of IT literacy. However, only 3 participants reported having prior experience with an Android phone.

From the participant perspective, the test script goes as follows. First, a short introductory discussion with the facilitator explains the purpose of the study, the project it takes part on, the test scenario, the experimental set-up demonstrated in the test scenario (with no mention of it being a WOZ), and the various tasks to be performed during the test. A consent form is signed to confirm participant's awareness of these issues and ensuring anonymity during result dissemination. Then the four transfer methods are experienced in sequence (randomly varying from participant to participant to minimize learning effect and presentation order bias) following the same scheme. First, the facilitator introduces the test scenario in which the participant is to transfer video content from the mobile device to the TV screen. The test scenario (similar to the Migrantes project's one used in [X]) is simple as it reflects a mundane situation: The participant arrives home from a bus trip during which s/he was watching videos on the mobile device. Upon returning home, s/he wishes to resume watching the video on the living room's large TV set. The facilitator then instructs the participant to select the transfer method to be tested, and explains how to actually perform the transfer with the selected method. The participant comments orally on each of the four concepts right after experiencing it, and the facilitator takes notes of the comments. After having tried the four concepts, a follow-up discussion takes place during which the participant is asked to orally indicate and justify her/his preferred method. The discussion also addresses the participant's experience with the four methods, and any relevant comment is written down by the facilitator.

5.2. Results of experiment I

5.2.1. Transferring content from a mobile device to a TV

All participants understood the given tasks and managed to complete them without problems or need of any help. The average completion time per participant was 15 min. None of the participants became aware of the WOZ approach, which was fully transparent.

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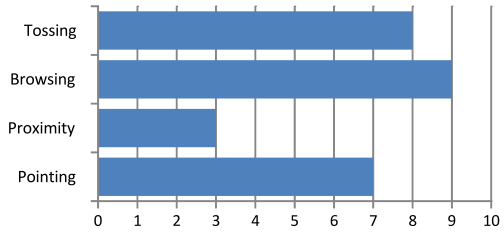

Fig. 6. Frequency analysis of method preference.

In between trying out the different methods, the participants were asked to verbally express their immediate impression of the individual methods, which was noted by the facilitator.

In order to investigate if any of the evaluated concepts were superior to the others each participant was orally interviewed after trying out all four methods. During this interview the participants were asked to specify, and argue for, an explicit preference among the four concepts. The frequency analysis of this is shown in Fig. 6.

On a more general level, all participants furthermore liked the idea of being able to transfer content from a mobile device to a TV screen: All participants but one could easily imagine doing this on a regular basis in their own homes.

5.2.2. Discussion

When looking at the frequency analysis shown in Fig. 6 no significant conclusion can be drawn, although there appears to be a general dislike against the Proximity concept. In order to understand the criteria according to which the participants rated the four transfer methods, their suggestions and comparisons stated during the oral interviews have been concatenated to identify trends. Out of the 246 comments expressed by participants, 74 were discarded as they did not provide reasons for evaluating the methods. In the remaining 172 comments, Tossing and Pointing have been frequently mentioned as superior to the other concepts. Ease of use, trustworthiness and fun appeared as important characteristics for a particular transfer method to be liked. On the contrary, the need to engage in physical activity was the most mentioned reason for disliking a method. This opposition to physical activity confirms the conclusions drawn in [18], and better justifies the low popularity of Proximity. Indeed the need to get up from the couch to reach the TV set was repeatedly found undesirable or irrelevant. Nevertheless, as in [18] participants appreciated the close connection between devices required by that method, giving the content transfer a feeling of reliability and security.

The set of comments has been categorized in order to determine potential convergence and deduce a crystallized set of preferential indicators. In total, 20 indicators were identified, as illustrated in Table 2.

A Principal Component Analysis (PCA) was then conducted, ordering these indicators according to their contribution to 3 dimensions. Performing a PCA allows reducing a large number of parameters (in our case the preference indicators) into a smaller set of dimensions while maintaining a high proportion of the variance of the original set of parameters. Here, the cumulative percentage of variance for Dimensions 1 and 2 account for 79.40% of the total variance, which means that these two dimensions alone carry nearly 80% of the total weight for all 20 indicators. Table 2 furthermore shows that these two dimensions represent 100% of the indicators *Reliable*, *Inconvenient with movement*, *Specific*, *Annoying with movement* and *Unreliable*. It is therefore considered appropriate to discard Dimension 3. Only indicators with a cumulative score for Dimensions 1 and 2 superior to 0.5 are considered, and collapsed into the following six dimensions to be evaluated in the second study: *Reliability*, *familiarity*, *convenience*, *cleverness*, *annoyance* and *intuitiveness*. These dimensions thus represent the most salient characteristics of how users perceive the transfer methods, as identified by the test participants. The naming of the 20 indicators and the 6 deduced dimensions adopts the participants' wording, in order to avoid introducing potential misinterpretations. It should be noted that generic indicators such as *good* or *nice* were discarded, for their lack of precision at describing preference.

6. Experiment II: Evaluating the indicators

The purpose of this second experiment is to clarify the results from Experiment I by further investigating the reasons that lead participants to prefer one method over the others.

Twenty new participants from the same demographic group as in Experiment I took part in the second study. They experienced the four transfer methods through the same procedure as for Experiment I, the only difference being the evaluation procedure of the methods. As in experiment I, none of the participants noticed the WOZ approach. After trying each method, the participant evaluated the six following statements related to the indicators:

- *I find this method **reliable**.*
- *This method seems **familiar** to me.*
- *This method is **convenient** to use.*
- *This method is a **clever** way to transfer content.*

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Table 2
Distribution of the 20 indicators according to the three dimensions computed by the PCA. Indicators below the dashed line were discarded due to their too low score.

	Dim 1	Dim 2	*Dim 3*	Dim1+2
Reliable	0.655	0.345	*0.000*	1.000
Inconvenient With Movement	0.655	0.345	*0.000*	1.000
Specific	0.655	0.345	*0.000*	1.000
Annoying With Movement	0.655	0.345	*0.000*	1.000
Unreliable	0.201	0.799	*0.000*	1.000
Nice Interface	0.940	0.025	*0.035*	0.965
Intuitive	0.088	0.844	*0.069*	0.931
Interesting	0.015	0.888	*0.097*	0.903
Not Nice Interface	0.730	0.172	*0.098*	0.902
Good	0.021	0.877	*0.103*	0.897
Inconvenient	0.461	0.418	*0.120*	0.880
Clever	0.506	0.338	*0.155*	0.845
Nice	0.250	0.541	*0.210*	0.790
Familiar	0.606	0.000	*0.394*	0.606
Easy	0.306	0.160	*0.534*	0.466
Simple	0.304	0.101	*0.594*	0.406
Cool	0.116	0.237	*0.647*	0.353
Slow	0.036	0.066	*0.898*	0.102
Logical	0.036	0.066	*0.898*	0.102
Efficient	0.008	0.023	*0.969*	0.031

	eigenvalue	% variance	Cumulative %
Dim 1	0.34	44.91	44.91
Dim 2	0.26	34.49	79.40
Dim 3	0.16	20.60	100.00

- *I find this method* ***annoying***.
- *This method is* ***intuitive***.

Participants expressed their agreement with each statement on a continuous linear scale marked from 0 (Completely disagree) to 10 (Completely agree). The statements were presented to participants on a separate sheet of paper for each transfer method.

After trying all four methods, participants ranked them in order of preference, from 1 (most preferred) to 4 (least preferred). This allows verifying the quality of the six statements as predictors of preference. The order in which the methods were presented had no impact on the rank given by participants (Pearson Product Moment Correlation score $r = 0.08$).

6.1. Results of Experiment II

Three main conclusions can be drawn from Experiment II. Browsing and Pointing are significantly preferred to Tossing and Proximity when evaluating these four transfer methods against each other. The levels of all indicators but *intuitiveness* vary significantly depending on which transfer method they describe. However the most preferred transfer method does not necessarily reflect the highest score in all dimensions. The score for the six indicators deduced in the first experiment reflect the exact ranking of the four transfer methods with an absolute correlation of 0.79. In fact, only three of the six indicators reflect the ranking with an absolute correlation of 0.78. The following sections describe these results in greater detail.

6.1.1. Preferred methods

A combination of Friedman and Wilcoxon tests on the scores computed for the transfer methods provides deeper understanding of which method is preferred over which. Such tests are performed instead of respectively ANOVAs and paired t-tests due to the non-Gaussian distribution of the measurements, as can be verified visually from the Normal Quantile–Quantile plots of the ratings provided in Fig. 8 in Appendix. Additionally, the measurements are repeated, which excludes using methods such as the Kruskal–Wallis or Mann–Whitney tests.

The Friedman test first informs us about the variation between the scores attributed to each transfer methods (column $Score_{all}$ in Table 3). Despite the test indeed showing significant variation ($p < 0.001$), it does not indicate the significance level of the variations between methods. A series of Wilcoxon signed rank paired tests are therefore performed to determine

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Table 3
Correlation between scores and method ranks exemplified by the data from participants 1 and 2.

Part.	Methods	Indicators						$Score_{all}$	$Score_{fca}$	Rank	Correl. $Score_{all}$	Correl. $Score_{fca}$
		Reliable	Familiar	Convenient	Clever	Annoying	Intuitive					
1	Browsing	8.39	2.55	8.13	7.81	1.41	6.30	0.70	0.64	1	−0.872	−0.92
	Proximity	7.40	1.51	1.46	2.97	8.44	1.93	0.28	0.15	4		
	Pointing	6.88	1.56	4.11	4.27	6.51	1.77	0.37	0.31	2		
	Tossing	2.55	2.08	3.28	3.02	6.98	2.92	0.28	0.28	3		
2	Tossing	6.93	8.91	8.80	8.85	2.92	3.75	0.74	0.83	1	−0.639	−0.84
	Proximity	3.02	9.01	1.25	7.19	7.40	8.96	0.53	0.43	4		
	Browsing	8.75	8.70	6.67	6.98	2.19	8.44	0.79	0.77	3		
	Pointing	7.14	5.94	8.23	8.07	1.61	6.15	0.73	0.75	2		

Table 4
Ratings and variance significance for each indicator. Significance levels are: *: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$. Boldfaced numbers illustrate first rank and best scores for each indicator (lowest score for annoyance and highest for others) and italicized numbers illustrate last rank and worst scores (highest for annoyance and lowest for others).

Method	Indicators						
	Reliable (**)	Familiar (***)	Convenient (***)	Clever (**)	Annoying (*)	Intuitive	Rank score
Tossing	*6.20*	5.34	6.06	6.52	3.29	*6.52*	4
Proximity	7.04	*4.76*	*4.10*	*5.76*	*4.69*	6.78	*0*
Browsing	**8.05**	**7.48**	7.18	6.84	**2.51**	6.86	**10**
Pointing	6.87	6.10	**7.34**	**7.35**	2.71	**7.24**	6

between-method variation significance. This allows us to conclude the following preference relationships between the four transfer methods and their level of significance:

- Browsing is significantly preferred to Tossing ($p < 0.05$)
- Browsing is significantly preferred to Proximity ($p < 0.001$)
- Pointing is significantly preferred to Tossing ($p < 0.05$)
- Pointing is significantly preferred to Proximity ($p < 0.001$).

The lack of significance between Browsing and Pointing and between Tossing and Proximity prevents any conclusion regarding these two associations.

In the light of the previous analysis, it can be concluded that out of the four transfer methods, Browsing and Pointing are significantly preferred over Tossing and Proximity. Coming back to the classification of the four methods depicted in Fig. 2, this result can be interpreted as: low levels of physical activities and novelty are preferred to their higher counterparts. The next section attempts to uncover the reasons behind this result.

6.1.2. Dimension ratings distribution among transfer methods

In order to understand how the six preference indicators describe each method, one can study the individual scores for each indicator and compare their variance among the four transfer methods. Table 4 summarizes the average score associated with each indicator for each method. The *Rank score* column illustrates how often the corresponding method has been selected as preferred (rank 1) by the participants.

From Table 4 we can first conclude that the preferred method as selected by the participants (Browsing) is also the method judged as most reliable, most familiar and least annoying. Additionally, it is remarkable that the best scores for all six dimensions are attributed to either one of the two preferred methods (Browsing and Pointing), while the worst score for all dimensions are attributed to the two least preferred methods (Proximity and Tossing).

By studying the variation of ratings among the four transfer methods for each preference indicator, it is possible to determine the degree of significance between the variations reported in Table 4. Once again, the non-Gaussian character of the measurements prevents from using ANOVAs when comparing the indicator ratings across the four transfer methods. Instead, we repeat the same procedure (Friedman and Wilcoxon tests) as for the analysis of the total score discussed in the previous section. Further justification for the decision of using non-parametric analysis methods over parametric ones are provided in Appendix.

From this analysis we can conclude the relationships between transfer methods illustrated in Fig. 7. It should be noted that no significant variation in intuitiveness has been measured among the four transfer methods. This could be explained by the low complexity of the user interface in the experiment, and the nature of the transfer methods, all based on interaction schemes supposedly well known to the participants.

6.1.3. The six indicators of preference

To verify the correlation between the participant ratings of the six preference indicators associated with each transfer methods and their final ranking of the methods, we attributed a score ($score_{all}$ in Table 3) to each transfer method based

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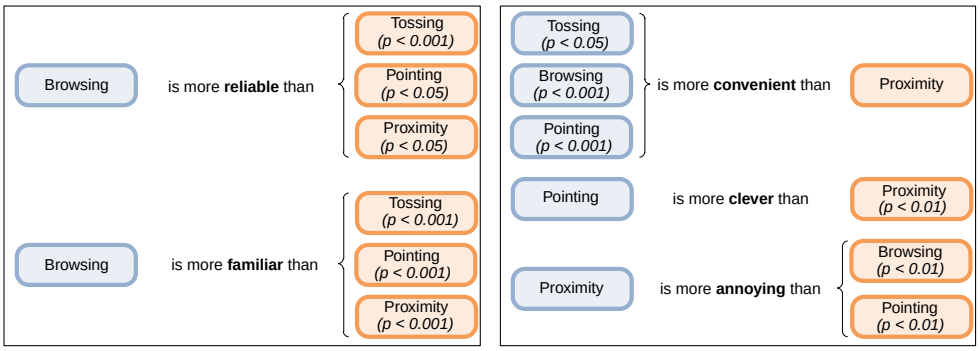

Fig. 7. Relationships between transfer methods in terms of preference indicators.

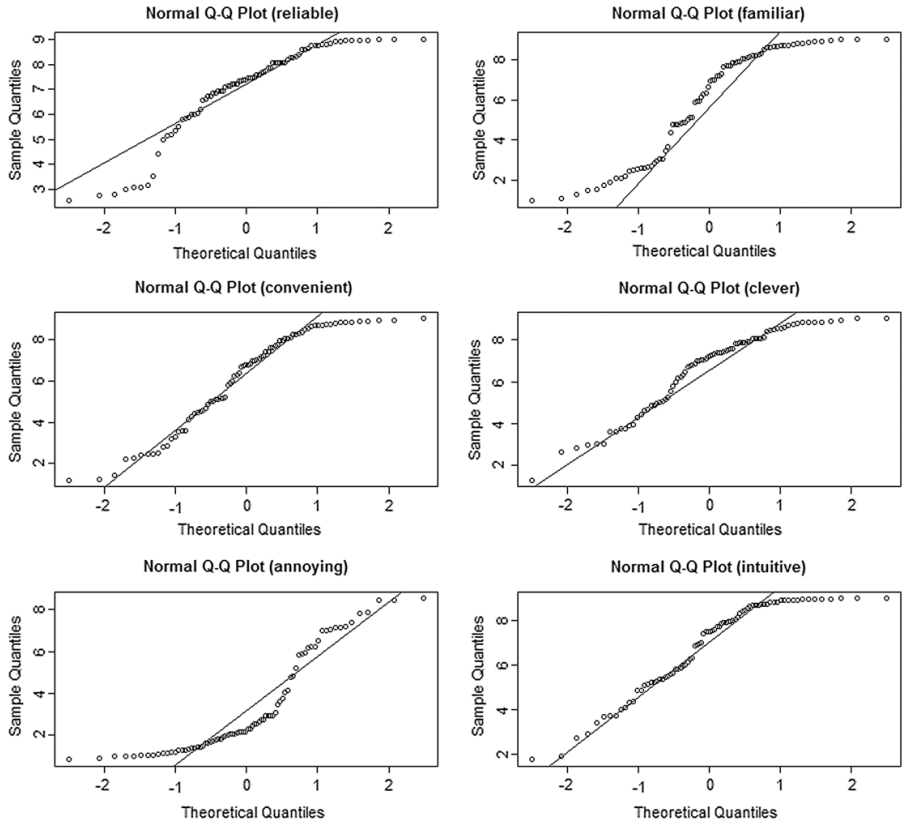

Fig. 8. Normal Q–Q Plots of the ranking distribution of each transfer method.

on the dimension ratings. The score was computed by calculating the normalized mean of the rating for each individual method, where the annoyance rating was inverted due to its negative connotation.

As an example, the ratings and associated scores are illustrated for participants 1 and 2 in Table 3. These two participants are used as example as they represent typical results. In this example, the Pearson Product Moment Correlation score (column *Correl*. $score_{all}$) indicates how well the score computed for each method from the indicator ratings (on a continuous 0–60 scale) matches the rank associated with each method (on a categorical 1–4 scale) by the participant. The average

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Table 5
Correlation between Preference Indicator Score and Method Ranking.

Reliable	Familiar	Convenient
0.60	0.98	0.90
Clever	Annoying	Intuitive
0.75	−0.93	0.31

correlation for all participants is $r = -0.79$, which indicates that the scores strongly reflect the ranks attributed by the participants to the transfer methods (the highest score is expected to be associated with rank 1 and the lowest score with rank 4, thus the negative correlation coefficient).

Furthermore, the effect of each indicator on the final rank is estimated by the correlation between the indicator ratings for each transfer method and the final rank of the method. As illustrated in Table 5, *familiarity*, *convenience* and *annoyance* seem to be the biggest contributors to the final ranking.

The large contribution of these three preference indicators to the final ranking can be verified by computing a score similar to that discussed previously, this time considering those three parameters only.

The average correlation between this new score ($score_{fca}$ in Table 3) and the ranking for each participant is −0.78, instead of −0.79 with $score_{all}$. This demonstrates that indeed most (98%) of the final rank is carried by the indicators of *familiarity*, *convenience* and *annoyance*.

7. Discussion

7.1. Generalization of findings

We have for this study selected a set of conceptually different methods spanning not only three of the fundamental unidirectional types of interaction: *Instructing*, *manipulating* and *exploring*, as suggested in [20], but also representing traditional interaction schemes in the living room when dealing with AV equipment. We therefore argue that our preference indicators can be also applied to other transfer methods than those evaluated in the study. We have furthermore evaluated these indicators in an equipment-independent set-up (i.e. only enacting scenarios that do not rely on device-specific functionalities), allowing us to argue that these findings are in general valid for evaluating transfer schemes between handheld devices featuring a touchscreen capable of displaying video content and fixed screens.

In summary, we postulate that when evaluating various methods of transferring video content between a mobile and a fixed device, measuring the level of familiarity, convenience and annoyance provides a good indication of the preference as seen from a user point of view.

7.2. Familiarity versus novelty

The importance of the familiarity dimension (being the most significance of indicator of preference) was implicitly seen already during the first experiment: Before being introduced to the four transfer methods, all participants were asked prior to the experiment how they would envision the transfer of video content from a mobile device to a fixed TV set. The vast majority of participants replied with technical solutions that are readily commercially available today. Then when evaluating the proposed transfer methods, they explicitly appreciated their familiarity to existing technology. Finally, after having tried the four transfer methods during the experiment, we asked the participants again if they could think of another way of transferring content between the phone and TV. Half the participants proposed alternative solutions, mostly based on existing interaction schemes (cable-based, docking station).

This behaviour can be traced to early childhood, during which after a short familiarization time, preference is given to a familiar stimuli rather than a novel one [21]. Additionally, it seems that familiarity with content supports mobile TV adoption: in a longitudinal study of mobile TV usage in Finland, it was reported that mobile TV watching behaviours were driven by habits from home television. As a result, the mainstream broadcast channels were largely preferred to channels specifically targeting the mobile platform, [22].

7.3. Transferring content back

Naturally, the transfer of content from the fixed to the mobile device is of importance too. During Experiment I, we briefly discussed this reverse scenario with the participants and found a need for consistency in terms of an interaction scheme. A thorough investigation is however needed in order to draw final conclusions in this regard.

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7.4. Design recommendations

Based on the findings from the two step experiment reported in this article, we would like to invite researchers and practitioners who design applications involving the transfer of video content from mobile to fixed devices to consider the following set of design recommendations in their investigations.

Levels of reliability, familiarity, convenience, cleverness and annoyance vary significantly among various methods for transferring video material from a mobile device to a TV set. The design process of such systems should thus integrate mechanisms for evaluating these indicators.

Furthermore, the design of such systems should be grounded in well-known practices already commonly in use in the home media environment. Indeed the noticeable "wow-effect" due to the novelty of the more exotic methods investigated in this study wore off as soon as participants reflected on the method and compared them to familiar interaction schemes.

Indeed content transfer methods should be designed in ways that arouse familiarity and convenience while preventing traits that could give rise to annoyance. This claim might seem obvious, however we think it necessary to remember that rushing into designing novel systems without considering these three parameters could lead to unsuccessful yet costly solutions.

8. Conclusion

In this article we have presented a usability study investigating user preferences in term of video content transfer from a mobile device to a fixed TV set. Based on a review of related work, the need for such transfers was demonstrated for a number of cases. Four representative transfer schemes were proposed: Browsing, Proximity, Tossing and Pointing. An initial experiment was conducted to identify the most salient indicators that users employed to distinguish the methods. These were: Reliability, Familiarity, Convenience, Cleverness, Annoyance and intuitiveness. These indicators we put to use and verified in the second experiment.

Here, the levels of familiarity, convenience and annoyance for a set of given transfer methods have been found to be highly correlated with the actual ranking of these, when seen from the users' perspective.

The second experiment also established that Browsing and Pointing were the preferred methods compared to Proximity and Tossing using the aforementioned indicators.

These results and conclusions are useful when designing cross-media applications, not only from a concrete point of view regarding the preferred transfer methods, but also from a methodological approach as the most salient indicators for user preference have been identified.

However, these conclusions should be interpreted within the context and limitations of the experiments. Based on these limitations, we suggest four tracks for possible future investigations elaborating on the findings and design recommendations deduced from the present study. Firstly, this study focused on the specific case of transferring video material between mobile phones and television sets. One potential extension of this work would be to verify the extent to which the preference indicators identified in our study apply to other types of content, such as photos, comments, application interfaces, and so on.

Secondly, we believe that the four chosen transfer methods span appropriately the novelty/physical activity space, which is deemed relevant for this type of study. Nevertheless, investigating additional methods covering combinations not depicted in Fig. 2 would further emphasize the validity of the findings presented in this article and/or uncover additional issues.

Thirdly, the lab-based setting and WOZ approach lowers the ecological validity of the study by removing errors caused by misdetection of user's actions (such as pointing or tossing gestures). The gain was that all four methods performed equally well, meaning that influences from a non-perfect technological implementation were removed in the experiment. The aim of this work was not to study such influences, but it is clearly an issue that could be addressed in future studies, either by providing a fully automated service or by introducing errors in the WOZ set-up, which would e.g. enable systematic studies of user acceptance vs. error rates.

Finally, the demographics of the test participants are limited to college students. This population is representative of early adopters of technology, which may bias their general interest in systems such as the one under scrutiny in this study. On the other hand, testing conceptual prototypes with prospect early adopters is believed to yield more relevant and informed feedback than with later adopters. Additionally, since the experiments were de-contextualized from the actual media contents and social environment, we assume the results to be generalizable, but a further study must show this conclusively, including among other demographic groups.

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5 http://www.cammp.aau.dk/, (November 18, 2011).

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Appendix. Choice of statistical methods

One important decision factor when selecting a statistical calculation strategy is the assumption that the measurements are normally distributed. A simple (but little reliable) method to detect potential normality consists in visually inspecting the distribution histogram. In our case, the histograms of the measurements for each transfer method tend to indicate non-normality. However it can be hazardous to base the choice of a statistical strategy on such assessment. Moreover, inspecting the Normal Quantile–Quantile plots (Q–Q plots) of the measurement distributions reveals the potential normality of the distribution as it illustrates the correlation between observed and theoretical quantiles (linearity of the plotted values pointing toward a higher possibility of normality). In the present case (illustrated in Fig. 8), the normality of the distribution is again not obvious. Furthermore, performing D'Agostino–Person omnibus tests for normality on the measurement distributions confirmed our decision to assume the distributions to be non-normal, and therefore conduct the statistical analyses using non-parametric methods.

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